SCIENTIFIC AMERICAN

The Monthly Journal of Practical Information

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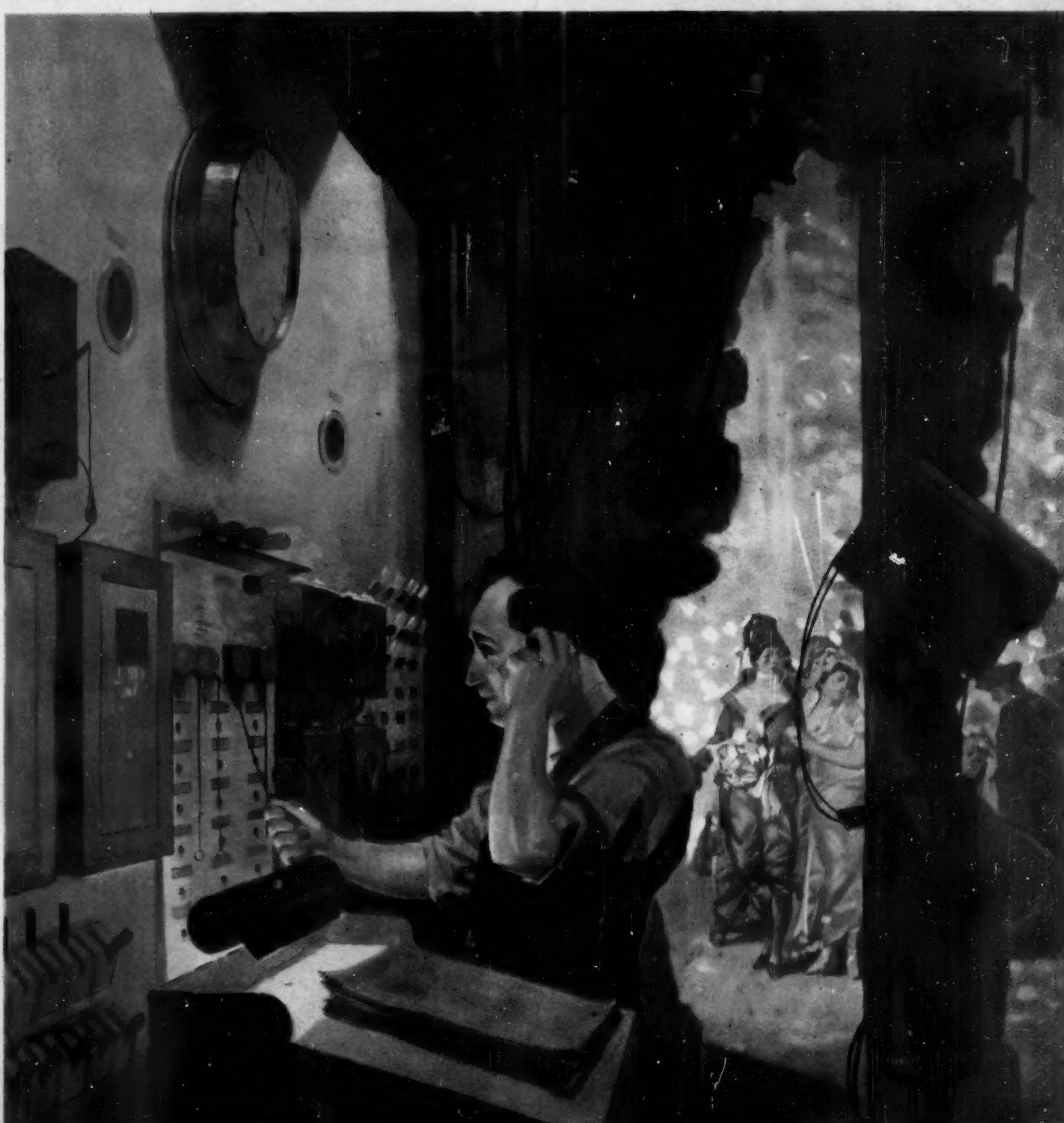

NEW SCIENTIFIC METHODS FOR THE CONTROL OF THEATRE LIGHTS

Scientific American Publishing Co., Munn & Co., New York

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An Announcement

With this issue there are several changes in our editorial staff. Mr. Austin C. Lescarboura has resigned as Managing Editor to enter a commercial business. Dr. E. E. Free assumes the direction of the magazine, as Editor.

Mr. Walker and Mr. Bird remain, Mr. Walker becoming Editor Emeritus, which means that he will be freed of editorial detail in order that he may continue to provide our readers with the thoughtful and authoritative articles for which he is so well known. Mr. Lescarboura, also, will be associated with the magazine as one of our Corresponding Editors and will have charge of the Radio page.

The policies of the magazine remain unchanged.

ORSON D. MUNN.
Publisher.

ON the 28th of August, 1845, the first editor of the SCIENTIFIC AMERICAN printed, in the first issue of this magazine, an intention which the newest editor does not believe that he can improve.

"We have made arrangements," he wrote, "to furnish the intelligent and liberal workingmen, and those who delight in the development of those beauties of Nature which consist in the laws of Mechanics, Chemistry and other branches of Natural Philosophy—with a paper that will instruct while it diverts or amuses them and will retain its excellence and value when political and ordinary newspapers are thrown aside and forgotten."

The present editor could not express more exactly his own hopes for your magazine.

IN that same first issue of the SCIENTIFIC AMERICAN Mr. Porter announced what the magazine was to contain. "Each number will be furnished," he said, "with from two to five original engravings, many of them elegant, and illustrative of *New Inventions, Scientific Principles and Curious Works;* and will contain, in addition to the most interesting news of passing events, general notices of the progress of Mechanical and other *Scientific Improvements;* Scientific Essays illustrative of the principles of the sciences of Mechanics, Chemistry and Architecture; useful information and instruction in various Arts and Trades; Curious Philosophical Experiments; Miscellaneous Intelligence, Music and Poetry."

Except for the "music and poetry" that is what we offer still, and possibly the absence of the lyric arts is compensated by the fact that Mr. Porter's "two to five original engravings, many of them elegant," are represented in the present number by well over a hundred engravings, most of which are quite as "elegant," we hope, as any that were available in 1845.

IN 1845 Professor Joseph Henry was in the thick of those immortal experiments on electromagnetic induction which constituted, as we now can see, the first step toward the marvels of radio. In the present issue we print an account of some experiments almost equally remarkable, those of General Ferrié and M. Jouaust, in France, in turning starlight into radio waves so that the passage of the time-star across the fine crossed wires of a telescope can actually be heard all over Europe—could be heard, if anyone took the trouble, all over the world.

Both in its present accomplishment and in its implications for the future, the research which our special Paris correspondent, Mr. Delano, describes on page 310 is probably one of the most significant which the SCIENTIFIC AMERICAN has printed in all of its eighty years.

IN 1845 no one had heard of the theory of relativity. Einstein was unborn. Physical science was still based on the famous Laws of Motion enunciated by Sir Isaac Newton.

Seventy-five years later the SCIENTIFIC AMERICAN was announcing its Einstein Prize and publishing its prize essay on the Theory of Relativity. In this issue, we begin what will be, we believe, another noteworthy contribution to the public comprehension of the remarkable scientific revolution which Einstein and his followers have brought about.

On page 305 of this issue the distinguished Russian mathematician and physicist, Dr. Nicholas P. Rashevsky, contributes the first of a series of eight unusual articles on the modern theories of relativity—not on what the Einstein theory is, but on what the Einstein theory *means;* on how it has quickened and altered our knowledge of physics and philosophy, our ideas about the real nature of the world.

This month Dr. Rashevsky lays a part of his foundation by discussing the nature of space. He will follow with discussions of the meaning of time, of the reality of the fourth dimension, of the size and curvature of the universe, of the character of matter, of the discovery of ultimate reality. No one who wishes to understand the newest scientific ideas of time, of space, of matter dare miss any part of this important series.

EVER since 1845 it has been the pride of the SCIENTIFIC AMERICAN to publish the reports of scientific researches from the pens of the men who did them. Our leading article this month is an instance.

The remarkable work of Dr. Winslow on deafness has attracted much attention in professional circles. In the Doctor's article in this issue he describes just what he does, how he does it, and why it works.

If you have a friend who is deaf this article is one of the things in this issue that you cannot afford to miss.

ONE of our readers, Mr. G. H. Taber, of Pittsburgh, has been good enough to point out an error which crept into the article on fused quartz published in the July issue. On page 59 we said of clocks they run "faster as the weather gets warmer and the bob (of the pendulum) longer." Of course, this should have been exactly the other way around. The clock runs slower as the pendulum gets longer. We are obliged to Mr. Taber. We are sorry. We will try not to do it again.

AS this issue goes to press there is a report from Paris of the discovery of a possible new cure for cancer, a cure based upon an unusual application of electric energy. The report comes from the *Société de Biologie*, an entirely reputable scientific society. Nevertheless it may be untrue or exaggerated.

We have cabled to our Paris correspondent to investigate. Circumstances permitting, we will tell you about it in the next issue.

NO articles ever published by the SCIENTIFIC AMERICAN have exceeded in popularity the serial written by Mr. Walker under the title "The Story of Steel," the tenth chapter of which appears in this issue. Our readers will be glad to know that Mr. Walker has consented to turn his searching eye and his trenchant pen on another of the great American industries—the oil industry. Mr. Walker leaves soon for the oil fields in California and the Midwest. Before his series on steel is concluded we hope to begin his articles describing a thorough-going study of the production, refining, and marketing of oil.

WHY is the price of gasoline so high? Can crude oil be safely left in underground reserves? Is oil more valuable for chemical purposes or for fuel? These are pressing questions already. They will be more pressing soon. They are some of the questions that Mr. Walker will study and answer in forthcoming numbers.

With the Editors

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EIGHTIETH YEAR

SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, NOVEMBER, 1924

Helping Deafness by Nerve Stimulation

A Description of Some of the Newest Discoveries of Medical Science About the Human Ear, Its Deterioration and How It Sometimes Can Be Improved

By Paul V. Winslow, M.D.

Member of the American Medical Association, Member of the American Public Health Association, Member of the New York State Medical Society, etc., etc.; Consulting Ear Surgeon, Brooklyn State Hospital, Brooklyn, New York; President, National Round Table for Speech Improvement; Formerly Instructor, New York Post-Graduate Medical School

IN ACCEPTING the invitation of the SCIENTIFIC AMERICAN to describe my recent experiments in treating deafness by stimulating nerve endings in the nose I must first caution my readers, both lay and professional, that this procedure is by no means a panacea in all cases of deafness.

Deafness may be due to a great variety of causes. Some are now curable by methods well known to the aural profession. Others—unfortunately—are still beyond the reach of any procedure that the profession has been able to devise.

How much it is possible to do for any person who is deaf will depend upon *why* he is deaf; upon what particular part of the delicate hearing mechanism has broken down or has ceased to behave in the manner that Nature intended.

But in those cases in which the deafness—especially partial deafness—is caused by some sticking together or thickening or undue friction in the complicated machine of bones and membranes and muscles that makes up the ear, especially in the cases in which this has been brought about by some catarrhal or similar irritation, then there is a good chance that nerve stimulation—plus the exercise of the ear machine that nerve stimulation brings about—will be able to produce a considerable improvement.

In one case, for example, the patient, a professional man forty-seven years old, could hear speech with the right ear only when the lips of the speaker were within six inches of the ear. With the left ear he could hear nothing at all. A course of nerve stimulation resulted in the ability to hear speech at a distance of three feet for the right ear and six inches for the left ear. Since the intensity of a spreading sound decreases with the cube of the distance from its source, this means that the hearing of this particular right ear was increased 216 times by the changes that nerve-caused exercise was able to bring about.

What is this nerve stimulation and nerve-caused exercise? It is very simple, although not, of course, simple enough to be practiced by the layman or by anyone except a trained aurist.

Just above the upper part of the air passage which extends inward from the nose there is a little knot or granule of nerve tissue which anatomists have named the spheno-palatine ganglion. The term "ganglion" is merely the general anatomical term for the knots of nerve cells that occur at many places in the body and that represent, we believe, a kind of exchange center for nerve messages, not unlike the telephone centrals which are the electric communication "ganglia" of a great city. The famous solar plexus located in the upper part of the abdomen belongs to this group of nerve ganglia, although it is both larger and more important to the body than is the ganglion with which we are here especially concerned: the spheno-palatine one inside the nose.

Now students of anatomy, who have been dissecting and studying the human body for so many years, have traced with microscopic care all the tiny nerve fibers that run in and out of this small "telephone central" that constitutes the spheno-palatine ganglion. Some of these nerve fibers—the "telephone wires" of the ganglion "central"—are found to run to the teeth, others connect with the lining of the eye socket, still others supply parts of the lining of the nose and parts of the Eustachian tube that connects the middle portion of the ear with the throat. Other fibers run, of course, to the main "trunk cable" of one of the greater nerves of the face and thence, by means of this great cable, to the brain.

And, what is most important of all for our purposes, some of the nerve-fiber telephone lines from this spheno-palatine ganglion run to the tiny bones and muscles and membranes that constitute the working parts of the ear.

How does all this help us to treat the ear? Simply this. By stimulating the spheno-palatine ganglion we can set up strong nerve impulses in all the nerve-fiber "wires" that reach out from it. Some of these impulses go along the fibers of the ear. There they produce, we believe, certain motions and activities that are beneficial.

It is as though some giant took hold of the building of a telephone central and shook it violently. This would result, we may well imagine, in a series of instant messages over the wires. Distress calls would go out to other centrals. Someone would call for the repair men, maybe even for the fire department. Instant activity would spring into being in half a hundred different places; from, perhaps, the calling out of the police patrol to a message of information to the president of the telephone company.

That is about what happens when a skillful operator reaches into the nose and touches the location of the spheno-palatine ganglion. A message goes to the "president" in the brain; this, in ordinary language, is the sensation of touch that the patient feels when the instrument makes contact with the proper spot. Another message calls out what might be called the bodily repair department in the form of a stimulation of the circulation of the blood to all the organs and tissues supplied with nerve fibers from this ganglion.

And, what is more important to the present discussion, a nerve message to the parts of the ear produces a set of shakes and quivers of all the tiny bones, muscles and membranes of which the ear is composed.

To see just how this can be of any benefit in cases of partial deafness we must digress for a few paragraphs into a description of just how the human ear is put together.

The external ear that we see is not an organ of hearing. It is merely a sort of sound-funnel to catch and concentrate the sound waves, much as the cone of a megaphone will do if you hold it to your ear. The sound waves thus caught are directed by the curve of the visible ear into the hole or "external canal."

Back a little way in this canal, one inch or so inside the head, we come to a membrane stretched tightly across the canal and closing it entirely. This is the so-called "ear drum." It marks the end of the external part of the ear and the beginning of what the anatomists call the "middle" ear.

Inside this middle portion are three curious little bones, the smallest bones in the human body, and in many ways the most remarkable ones. One of these bones looks like a hammer, one looks like an anvil, and the third looks like a stirrup. Their technical names, in fact, are these three words, hammer, anvil and stirrup, translated into Latin.

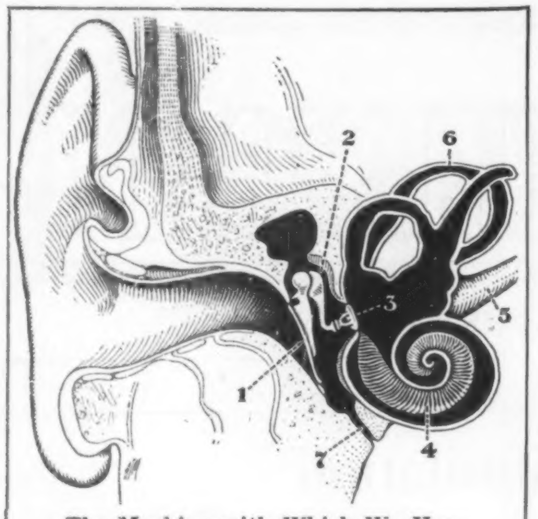
What these bones are, in reality, is a lever system to magnify sound. The sound waves coming in from the external ear strike against the ear drum and set it into vibration, just as one head of a bass drum will vibrate from the sound waves produced when the other head is struck, or just as the drum-like head of a banjo will vibrate for the same reason when a string on it is plucked.

Attached to the inner side of the ear drum is one of the three small bones. The second bone is attached, by a more or less flexible joint, to this first bone. The third bone is attached to this second one and, at its farther end, to the part of the ear that is still beyond; the so-called "inner" ear that contains the actual organs of hearing.

This inner ear we will describe presently, but for the moment let us focus our attention on the middle ear and its chain of three small bones. These bones, I have said, are a lever system. The sound vibrations coming

The Modern Way of Testing Hearing

Dr. Winslow is operating the Western Electric Audiometer, an electric instrument for testing the acuteness of hearing of the patient seated in front of the Doctor. Meanwhile the nurse records the exact intensities of the tones of different pitches which the patient can hear



The Machine with Which We Hear

The ear drum, or outer diaphragm of the ear, is indicated at 1. 2 indicates the chain of three small bones that acts as a lever system and increases the intensity of the sounds. At 3 is the end of the third small bone (the stirrup) and the second diaphragm or "window" that communicates with the inmost part of the ear. The real organ of hearing, consisting of the coiled-up strip of nerve fibers, is shown at 4. 5 marks the auditory nerve, over which the nerve messages that indicate the sounds are carried to the brain. At 6 are the famous "semicircular canals," not used in hearing, but which are believed to control the balancing sense that enables us to stand erect

from the ear drum cause the first bone to vibrate. This sets the second bone to vibrating, and it, in turn, starts off the third bone. The sound vibrations pass, therefore, along the entire chain of bones in order to arrive, at the end, at the door of the inner ear.

The bones are of such shape and are so connected that when this happens the sound vibrations are increased in magnitude. The levers do it. If you move the short end of a lever through a short distance, the long end of the lever will move a long distance. The three levers of the three bones do this, three times in succession, for the vibrations of the sound.

It is somewhat the same as the action of a phonograph needle. This needle, running over the bottom of the tiny groove in the record, acquires a succession of very small motions or vibrations corresponding to the microscopic dents in the record. The needle is connected to a long-armed lever system. This lever system magnifies the vibrations acquired by the needle from the record, so that when these vibrations have reached the actual sound-producing diaphragm of the phonograph they are much stronger than they were in the beginning.

Just so, in the middle ear the three-bone chain of levers magnifies the vibrations that come in through the ear drum.

The inmost ear of all, the so-called "inner ear," begins with another drum or membrane-covered window. To this membrane the third bone of the chain is attached, just as the first bone is attached to the main ear drum which separates the middle and the external ears.

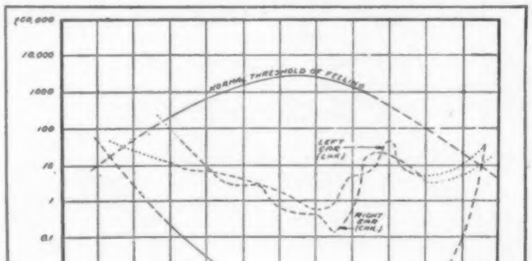
Inside the window to which this third bone is attached there is a small sack filled with a watery liquid. Suspended in this liquid is a very remarkable membrane coiled up in the form of a spiral, like a sea shell. This is the famous "Organ of Corti," so named by the anatomists in honor of the great physician who discovered it. It is the real machine by which we hear.

Along the length of this Organ of Corti are arranged some thousands of nerve fibers, each one stretched out like the strings of a harp. These fibers vibrate in response to the different sounds. Each fiber connects to the brain through the great auditory nerve. When these fibers vibrate, the sensation of sound is produced in the brain.

Notice the remarkable succession of things that must happen if you are to hear a sound, such, for example, as the spoken vowel "ee." First the sound waves from the throat of the speaker go out through the air and reach your external ear. Here the waves are reflected into the ear canal. Next they strike against the ear drum and set it into vibration. This vibration is communicated to the three bones and passes along them, being magnified the while. When it reaches the second drum or window into the inner ear, this window, in its turn, is set into vibration. This causes a vibration of the watery liquid in the inner ear. The liquid communicates this vibration to the harp-string-like fibers of the Organ of Corti. The proper ones of these fibers vibrate. A nerve message goes to the brain. You hear the sound.

All this complicated sequence of actions occurs within a small fraction of a second. So far as our brain knows, it occurs instantly. Yet every single step of it must occur and must occur properly if your hearing is to be as delicate and as accurate as the ordinary business of life makes necessary.

You can see, now, how easy it is for something to happen that would make you deaf. If the inner ear is punctured so that the watery liquid gets out; if the Organ of Corti becomes diseased or if the nerve fibers in it get detuned so that they cannot respond properly to different sounds; if the nerve connection with the brain by way of the auditory nerve gets dislocated somehow; if the window leading to the inner ear grows hard and stiff so that it can no longer vibrate; if one of the three bones falls out of the lever system or if something happens to this system so that sound vibrations will no longer pass along it; in any one of these



Hearing Curve of a Normal Ear

Recent scientific work on hearing, mainly in the laboratories of the Western Electric Company, has led to the discovery of the normal "area of hearing" shown on this curve. The two bowed lines mark the limits of this area; the up-and-down scale of the curve indicating intensity of tone, while the right-and-left scale indicates the pitch of the tone being tested. Note that to the right and the left the area of hearing narrows, showing that there are tones too low or too high in pitch for the ear to hear them. The lower bowed curve marks the intensity at which faint tones of the different pitches can just be heard. The upper bowed line marks the degree of loudness at which the tone becomes so loud that it is no longer heard in the ordinary manner, but begins to be felt as a more or less unpleasant vibration. The dotted lines inside the hearing area represent the curves of two individual ears, like the curves reproduced below

circumstances your hearing will either be destroyed or be seriously impaired.

The remarkable fact, when one considers the delicacy and intricacy of this hearing system, is not that some people are deaf. The real miracle is that anyone can hear at all.

Let us focus attention on the three bones. Suppose that something happens so that the joints between the three bones are no longer flexible. You see the inevitable result. The necessary magnification of the sound vibrations will not occur. It may even happen that the chain of bones becomes so stiff and rigid that no sound vibrations can pass through, even without magnification.

This has the same effect as though you spilt molten solder or sealing wax over the lever system of your phonograph. You would not expect, then, that the transfer of the sound vibrations from the needle point to the diaphragm at the small end of the horn would continue as perfect as it had been before. No more can you expect that three stuck-together bones in your ear will carry the sound successfully from the ear drum to the real hearing organ inside the inmost water-filled sack.

Now it happens, unfortunately, that one of the results of a catarrhal infection in the middle part of the ear, or, indeed, of any long-standing inflammation or irritation in this part of the ear, is just this effect of making the bones stick together. The chain of them grows more or less rigid. Hearing is impaired. This is one of the commonest causes of what is called catarrhal deafness.

To return now to our original question, how does the stimulating of the nerve center in the spheno-palatine ganglion help to cure this stuck-together condition of the three small bones?

Suppose that some day you forget a pair of scissors and let them lie out in the weather during a rainstorm or two. They will rust. The joint between the two blades will probably be rusted shut so that the scissors cannot be used. What do you do?

You work the joint back and forth a few times forcibly. This dislodges some of the rust. The joint works more easily. With a little of this "exercise" of the joint, aided, perhaps, by a little oil, you may be able to fix up your rusted scissors so that they are almost, if not quite, as good as new.

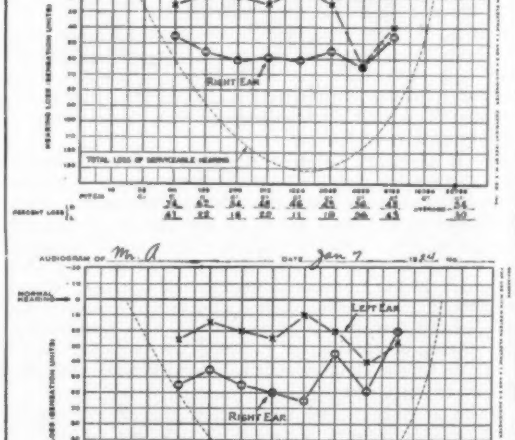
In the ear we can do this same thing to the stuck-together bones. Of course, we cannot actually reach into the middle ear and oil up the bones or work them back and forth with our fingers. But we can do the same thing in another way. That, in fact, is just what we accomplish when we stimulate the nerve ganglion in the nose.

The ear contains, besides the ear drum, the three bones, the window and all the rest of it, a number of tiny muscles. Some of these keep the ear drum stretched to just the proper degree; they correspond to the screws that the drummer has on his drum and that you see him readjust from time to time while the orchestra is playing.

Others of the ear muscles have the duty of keeping the three bones in just the proper places, of maintaining the proper tension and position of the window into the inmost ear, and the like. Every one of these muscles, tiny as they are, has its nerve fiber that goes out somewhere; many of them to the spheno-palatine ganglion in the nose.

Everyone knows that to stimulate a nerve produces a sudden contraction of the muscles to which that nerve is attached. When the doctor strikes your knee in the well-known "knee-jerk" test, the foot and leg fly up in response to such a muscular contraction of the leg muscles.

Just so, when we touch the ganglion in the nose and stimulate it, the signals that it sends out, like the signals when the giant shakes the telephone central, pro-



Two Hearing Curves that Show the Effect of the Nerve Stimulation Treatment

These two curves represent the hearing of the same patient; the upper curve before the nerve stimulation treatment was begun, the lower one several weeks afterward. The figures written in at the bottom of each curve show the relative degree to which the hearing was below normal for each of the tones tested, the pitches of the tones being indicated both in musical notation and in vibrations per second. Note that the deficiency of hearing in the right ear decreased from 54 per cent to 46 per cent, and that of the left ear from 30 to 22 per cent as a result of nerve stimulation

duce, some of them, contractions of the muscles to which the nerve-fiber wires are attached.

Among others they cause contractions of the tiny muscles in the middle ear. This shakes the three bones. The bones are moved forcibly on each other; adhesions between them are loosened; the movability and lever action of the chain of bones may be more or less restored.

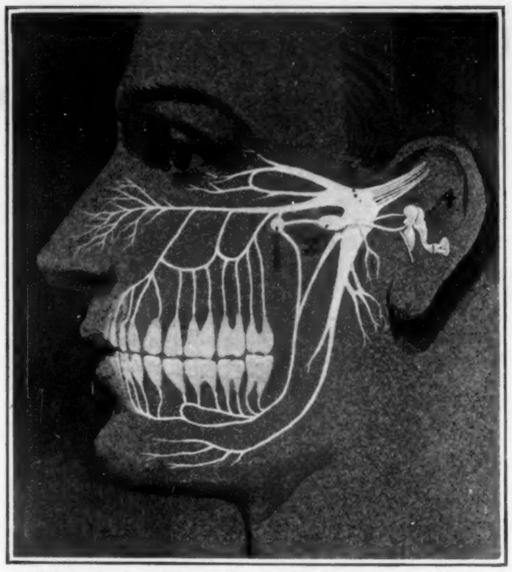
There is another effect that is probably important also. The muscles of the middle ear are themselves important to its proper working. If these muscles have grown stiff from disease or flabby from disuse, the ear will not work so well.

Everybody knows what to do for a stiff or flabby muscle. We exercise it. Touching the nerve ganglion in the nose exercises the muscles in the ear. We produce, then, at least two beneficial effects: we loosen up the three small bones and we strengthen the ear muscles by exercising them. It is probable that still other beneficial effects are produced, as, for example, an increased circulation of the blood, with resultant improved food supply to the ear organs and a better removal from them of the waste products formed by all living tissues.

Regardless, however, of the theory of the matter, there is now no question about the facts. In many cases the stimulation of the nerve center in the nose actually does produce a remarkable improvement of hearing. In instances which I have described already in professional publications, this improvement has equaled more than two million times, measured by the intensity of sounds that could just be heard. It is my belief that in cases of catarrhal deafness this comparatively simple procedure of ear exercise by nerve stimulation will produce a marked improvement in three-fourths or more of the cases that present themselves.

If this improvement is due mainly, if not entirely, to the mere exercise of the muscles and bones of the ear, the question arises why this cannot be accomplished by some more direct method than nerve stimulation. The answer is that it can.

Teachers of music and physicians specializing in the treatment of professional singers have long known that the mere act of singing for some hours a day will frequently improve catarrhal conditions and better the hearing of the singer. I have found, in addition, that pronouncing or even listening to the sound of the vowel "ee" will reduce inflammation and improve hearing in a way that seems sometimes almost magical.



Where the Nerves that Cause the Ear Exercise are Placed

The nerve trunks and ganglia, all much exaggerated in size, are shown in white. The spheno-palatine ganglion, which is stimulated first, is shown at 1. 2 is another knot of nerve tissue called the otic ganglion. The spheno-palatine ganglion communicates with the otic ganglion by a small nerve thread and the otic ganglion communicates, in turn, with the inner ear, shown at 4. This is how a stimulation of the spheno-palatine ganglion at 1 sends a nerve message to the muscles of the inner ear and exercises them. At 3 is the main trunk of the facial nerve which connects all these ganglia and nerve paths to the brain. Other branches of this nerve go to the teeth, as shown

The simplest explanation of these facts is that the movement of these sound vibrations through the machine of the ear exercises the parts of this machine, increases the circulation of the blood through them and duplicates, in part at least, the benefits of the exercise due to stimulation of the nerves.

I have found, furthermore, that radio can be of great assistance in a similar way. It is obviously impossible for a deaf person to be listening all the time to loud spoken words for the sake of ear exercise. Yet such exercise, continued for hours at a time, has been found a beneficial adjunct to the treatment by occasional nerve stimulation. Accordingly I am accustomed to prescribe for many patients a number of hours each day spent listening to radio programs.

The receiver should be so adjusted that the sounds coming from the head-phones or from the loud-speaker are loud enough to be audible by the patient; this requiring, in most cases, a higher degree of amplification than is necessary or pleasant for normal ears. As the patient's ears improve the loudness of the practice sounds may be gradually decreased.

In this way the exercise produced from within by stimulation of the nerves is supplemented by exercise produced from without by feeding loud sounds into the ear. Exercise by nerve stimulation corresponds to the usual gymnasium exercises, directed by nerve messages from the brain. Exercise by radio or other sounds corresponds, on the other hand, to those newly invented exercise machines that operate by pulling or massaging the muscles by means of an outside force.

However it be accomplished, there seems now no doubt that exercise of the parts of the middle ear, and possibly of the inmost ear as well, has a curative value in many varieties of partial or total deafness. As we learn more about the exact relations of the nerve fibers that run from these organs to the spheno-palatine ganglion and to other portions of the nervous system, we may be able to localize our exercises still more exactly and to control them more precisely.

We may be able, in the end, to manipulate, improve and control organs like the ear or the eye with almost as great precision as that with which the superintendent of a great telephone system control the electrical "fibers" and "ganglia" and other mechanisms that are under his direction.

Note

Physicians interested in the technical details of Dr. Winslow's work may consult the following papers by him:

"Significant Results Obtained in Treating Catarrhal Deafness," New York Medical Journal, October 18, 1922.

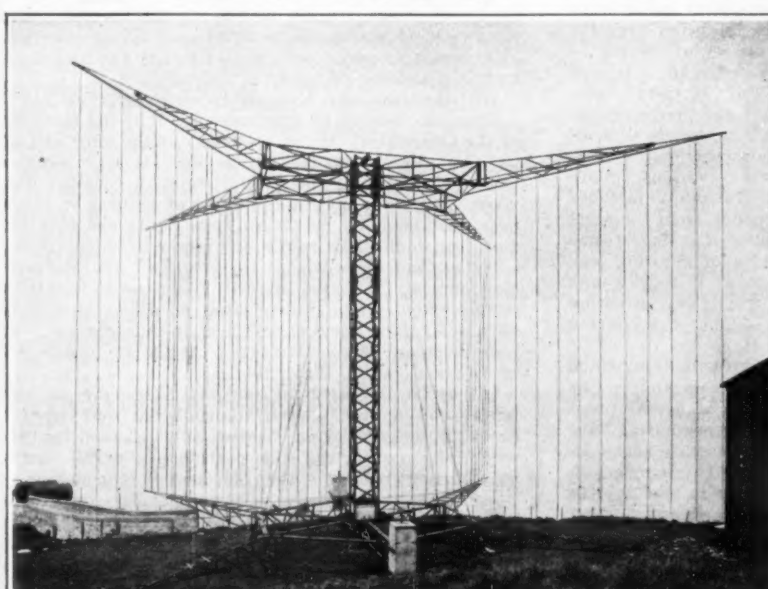
"Improving the Hearing in Catarrhal Deafness Through Stimulation of the Nasal Ganglia and the Trigeminal Nerve," New York State Journal of Medicine, August, 1924, pages 793-797.

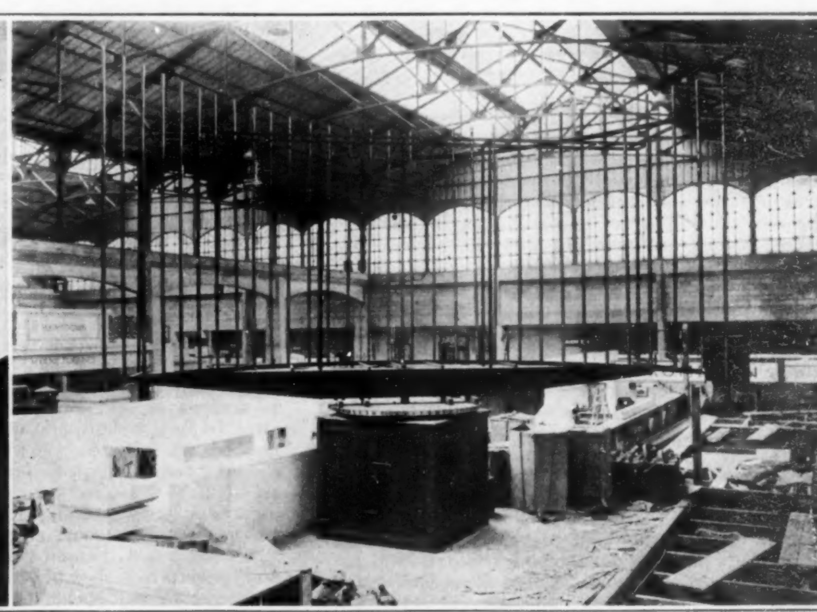
New Radio Aids for Saving Ships

As soon as the radio compass for detecting the direction of radio waves, was invented and applied to the use of ships at sea it became possible to construct at dangerous points on the sea coasts of the world a set of radio lighthouses to serve as adjuncts to the ordinary lighthouses which have been for more than twenty centuries the chief reliance of a mariner as he approaches port.

A recent improvement in these radio lighthouses consists in sending out, not merely a radio signal that goes broadcast in all directions, but an actual radio beam that goes only in one direction, like the beam of a searchlight. The transmitter employs the reflection principle for radio waves, as developed by Senator Marconi. The wire cage that serves both as transmitter and as reflecting mirror, is mounted on a central shaft so that it can be revolved. As it revolves, the "beam" of radio waves sweeps across the ocean surface just as the beam of a revolving searchlight does.

The transmitter shown here has been installed at Inchkeith, on the coast of Scotland. It has been in operation for over a year and has been recently rebuilt to embody important new improvements. The region where it is installed is especially subject to thick fogs and it is reported that the revolving radio lighthouse has already established its value, many times over, in the increased safety to ships and, more directly still, in the avoidance of delays due to fog off the port. It is probable that these radio beam lighthouses will be installed elsewhere on many fog-bound coasts.





The New Radio Beam "Lighthouse" Installed at Inchkeith, on the Firth of Forth, Scotland

At the left is the beam transmitter itself, as actually installed. At the right is a small model of the newest form of the transmitter, as it was being erected for exhibition at the British Empire Exposition, now in progress at Wembley. This model projects a radio beam on a wave length of approximately two meters

Our Psychic Investigation

Preliminary Committee Opinions on the "Margery" Case

By E. E. Free, Editor of the SCIENTIFIC AMERICAN

On the date when these paragraphs are written (September 17th) the Committee appointed to investigate alleged psychic cases and to determine the disposition of the SCIENTIFIC AMERICAN Award has been unable to reach a final and unanimous decision with regard to the mediumship of "Margery."

Some details of this celebrated mediumship have been recounted in previous issues of the SCIENTIFIC AMERICAN. It is hoped that others can be disclosed later. In the meantime, we present on this page the statements of four individual members of the Committee, setting forth their views concerning the case. The fifth member of the Committee, Dr. William McDougall of Harvard University, has been absent from Boston, has not participated in the more recent seances, and could not be reached in order to secure a formal statement for publication in this issue.

The statements of the members of the Committee follow. Except for that of the Chairman they are given in alphabetical order.

Statement by Dr. Prince

August 29, 1924.

I should have preferred to have more opportunities for attending sittings in the "Margery" case before making any statement. But realizing that the unfortunate publicity which the case has undergone may require that some report of progress shall be given to your readers, I will say what is proper now to be said.

So much of an opinion as is possible to give at this time, and by me, is based principally on six sittings at which I was present, and partly upon reports of sittings at which I was not present. In five of my sittings I was one of the immediate controllers, in one so placed that it was impossible in the darkness to form any independent judgment. The fourth and fifth were under a method of control to which the Psychic could and did urge objections based upon purported laws of the phenomena, although consenting to it in advance; the others were expressly approved by her circle. The first three presented physical phenomena, the last three none. Nothing of this nature occurred, the *possible* normal explanation of which was not to me immediately apparent, except one striking detail, but that was unfortunately during the only seance where I was so placed that I could not be a judge of the surrounding circumstances.

I am compelled to render an opinion that thus far the experiments have not scientifically and conclusively proved the exercise of supernormal powers.

Walter Franklin Prince

Statement by Dr. Carrington

August 29, 1924.

As the result of more than forty sittings with "Margery," I have arrived at the definite conclusion that genuine supernormal (physical) phenomena frequently occur at her seances. Many of the observed manifestations might well have been produced fraudulently—and possibly were so produced. Disregarding these, however, there remain a number of instances when phenomena were produced and observed, under practically perfect control. I cite, as an example, the continued ringing of the bell of the "contact apparatus," when both the medium's feet rested across my knees, being held there by my one elbow; both her hands were held firmly in mine, the arms pulled out to their full extent; and her head located by her talking at the time, at my request. The contact apparatus was on the floor; tipping of her chair would not have reached it (as I tested), and her shoes were on her feet, showing that they had not been removed and laid upon the contact board—which, moreover, was rung intermittently, at request. The degree of control I considered perfect, and the manifestation was repeated over and over again.

I am convinced that no snap judgment is of any value in a case such as this; nor will preventing the phenomena demonstrate their non-existence. The present case is peculiarly difficult, for many reasons; but I am convinced that genuine phenomena have occurred here, and that a prolonged series of sittings, undertaken in an impartial spirit, would demonstrate this.

Hereward Carrington.

Statement by Dr. Comstock

September 13, 1924.

My present attitude toward the "Margery" case, with the general background out of which it arises, may be briefly stated as follows:

It should be realized at the outset that any opinion regarding the reality of the phenomena in the "Margery" case has nothing whatever to do with "spirits" or any other theory as to the cause of the phenomena. The stipulations of the SCIENTIFIC AMERICAN were as to the existence of new physical phenomena only, such phenomena as the movement of objects, the change in temperature readings, etc., etc.

Cabinet built by Houdini and used in several sittings

I have consistently been opposed to the attempt to investigate such phenomena in utter darkness and I have believed that every effort should be made to have the phenomena occur in a lighted room if such were possible. The "Margery" "control" has repeatedly stated that the production of phenomena in the light, while much more difficult than their production in the dark, was only a question of getting used to the new conditions. Since in a field of this nature "get-wise-quick" methods are not likely to succeed, my policy from the start has been to attend a large number of sittings (some forty now, in all), with the idea of allowing phenomena in the light to "incubate" if they would, and at the same time paying little, if any, attention to events in the dark which might occur during this supposed incubation period.

I believe that in a field of investigation which has naturally awakened so much skepticism any phenomena to attain the dignity of actual proof must be very definite and often repeated. I have not yet seen in connection with this case such sufficiently definite and often-repeated phenomena in the light; but I have seen enough in the light to awaken a lively interest on my part, and I think the investigation should be continued.

My conclusion therefore is that rigid proof has not yet been furnished but that the case at present is interesting and should be investigated further.

Daniel F. Comstock

Statement by Houdini

August 28, 1924.

Summing up my investigations of the five seances I attended of "Margery," which took place on July 23, 24 and August 25, 26 and 27, 1924, the fact that I deliberately caught her manipulating with her head, shoulders and left foot, particulars of which I have handed to Mr. O. D. Munn with illustrations, and the blank seances and incidents which took place at the last three tests; my decision is, that everything which took place at the seances which I attended was a deliberate and conscious fraud, and that if the lady possesses any psychic power, at no time was the same proven in any of the above dated seances.

Houdini

These statements speak for themselves. There is nothing that the SCIENTIFIC AMERICAN can add to them, or that it is proper for the SCIENTIFIC AMERICAN to say about them.

In much of the newspaper discussion of the Margery case there has been evident a confusion concerning the relative business of the SCIENTIFIC AMERICAN and of the Committee, so far as this psychic inquiry is concerned. The facts are perfectly simple and have been on record from the beginning.

The SCIENTIFIC AMERICAN has offered awards aggregating five thousand dollars to be paid to those persons who succeed in producing certain varieties of supernormal phenomena to the satisfaction of the Committee. We stand ready to pay these sums whenever the Committee instructs us to do so. We are not the Committee. It is not our business to decide for or against the claims of any medium, Margery or another.

Nor is it our business to select the test or tests that are to be considered conclusive evidence of real phenomena or to say what events, if any, are to be considered conclusive evidence of intentional deceit. That, too, is the job of the Committee and of no one else.

The only duty of the SCIENTIFIC AMERICAN is to pay the award when we are told to do so and in the meantime to lend to the Committee such assistance as they request and to report from time to time such findings or announcements as they wish to make public.

That was the arrangement in the beginning. It is the arrangement now. It will be the arrangement until the Pyschic Investigation is terminated by the selection of a person to whom we are told to pay the award or by the limitation of time.

Will the tests with Margery be continued?

That, too, is none of our business. It is the business of the Committee. Under the terms of the offer and of the Committee's appointment no limit is set upon the length of time that the Committee shall consider any given medium or upon the number of seances or other tests that shall be held. No such limits are imposed now, nor would it be within our power to impose them.

If the Committee wishes to investigate the Margery case further, the Committee will doubtless do so. It is certainly their right and privilege to do so, assuming, of course, that Margery and her friends consent. It is no business of the SCIENTIFIC AMERICAN to say yes or no about it. So that's that.

It may be permitted us, however, to observe, as any reader can do for himself, that of the four reports herewith presented from members of the Committee two specifically recommend the continuance of the tests with Margery while another one implies that such continued tests are desirable. Three members constitute a majority of the Committee. It is a simple enough deduction, therefore, that the Committee will probably decide to make some additional tests.

When the Committee has additional results to report, whether on the Margery case or on any other, we shall tell our readers about it including, wherever possible, all details of what actually happened in the seance room. So long as the Committee makes no report, we too shall have nothing to say.

A New Einstein Series—Article I

The Possibility of Other Kinds of Space

By Nicholas P. Rashevsky

Special Lecturer at New York University; formerly of the Russian University at Kieff and of the Department for Russian Students at the University and Polytechnicum at Prague.

Dr. Nicholas P. Rashevsky

THERE is probably no living person, in literate countries at least, who has not heard about Einstein's famous theory of relativity and gravitation. But, on the other hand, many persons who seek an elementary and popular exposition of this famous theory are disappointed to find some of its most interesting features left largely undiscussed.

For example, what is meant by the "curvature of space?" How can the universe visualized by the relativity theory be both "unbounded" and "finite," as the theorists assert that it probably is? Are not "finite" and "unbounded" commonly regarded as contradictory terms? How can light be said to move in "straight" lines and yet follow a "curved" path, returning ultimately to its starting point?

From the standpoint of ordinary experience these paradoxes sound like nonsense. Yet the relativity theory is full of such paradoxes. They raise perplexing questions, questions which popularizers of the theory have mostly left unanswered, the excuse being that to answer them would require excursions into higher mathematics of such complexity as to transcend the equipment of persons not professional mathematicians.

There is, however, one analogy sometimes employed to explain the existence of something that is "finite" and yet "unbounded." This is the analogy of the earth. A man may start off in a straight line and walk around the earth; always moving straight forward and yet always returning toward his starting point, for if he but walked far enough and straight enough and assuming that no obstacles intervened, he would return in the end to the place where he began.

This is quite true. It is even, in a sense, a true analogy to the travel of a light ray around the universe. But the universe is "unbounded" in all three of the ordinary dimensions of space, which the earth is not. And the analogy of the earth fails to be fully satisfactory in that it gives us no mental picture of the way in which the "curved space" of the universe—obviously no ordinary three-dimension curvature—may really exist and may affect us and the world.

This article is designed to provide just such a picture; a definite, concrete, pictorial idea of what these remarkable new results of relativity studies really mean to our ideas of space in physics and in philosophy.

We all remember from our days in elementary school what is meant by geometry. It is that branch of mathematics which devotes itself to studying the relations between the shapes of things. We represent these shapes by what we call figures. Some of these figures are on planes, as, for example, lines, triangles, squares, and so on, drawn on paper. Other figures are three-dimensional, like cubes or spheres, or "oblate spheroids" like the earth. So there is plane geometry and solid geometry; one being the geometry of plane or two-dimensional figures, the other the geometry of the three-dimensional figures, that we call solid.

As an example of the relations studied in plane geometry, we may cite the familiar relation that all the angles of a plane triangle equal a total of 180 degrees, a relation that is illustrated by Figure 1. Another is the proposition that the square of the hypotenuse of a right-angle triangle is equal to the sum of the squares of the two sides. In Figure 2, if the side *AB* is three inches long and *BC* is four inches long, then the third side, the hypotenuse, equals five inches, this being the square root of 25, which is, in turn, the sum of the two other squares, 9 and 16.

An analogous relation holds in solid geometry. Thus the square of the diagonal, *CA'*, of the rectangular parallelopiped shown in Figure 3 is equal to the sums of the squares of the three sides, *AB*, *BC* and *AA'*. Familiar propositions like this lie at the root of all our geometrical thinking. Everyone accepts them. Anyone can verify them at will, for example by taking a ruler and actually measuring figures like those on this page.

The geometry which we study in the elementary schools is confined in the main to the geometry of straight lines and planes. The only curve studied is ordinarily the circle; the only curved surface is the sphere. This is the geometry founded by the great Greek genius, Euclid, who lived 2200 years ago. Accordingly, it is called the Euclidean geometry.

But geometry is not limited, necessarily, to the study of these kinds of shapes and figures. There exists an infinite number of curved figures that may be subjected to our study.

Take a sheet of paper and draw on it a plane triangle, like that of Figure 4. Then bend the sheet of paper, as in Figure 5. Obviously the dimensions of the triangle are unchanged. The length of the line *AB* remains just what it was before, although the bending of the paper has made the line now a curved line instead of a straight one.

The Real Nature of the World

Are the things around us real or are they illusions? Philosophers disagree. They admit that we cannot be sure. What we see as rocks and trees and houses and animals may be merely imperfect reflections of some ultimate reality that men do not perceive.

Can science solve this mystery of what ultimate reality is like? We believe so. The Einstein Theory of Relativity seems to be pointing the way. In the brilliant series of articles of which this is the first, Dr. Rashevsky will tell how and why this is so. This article describes the nature of space. Next month Dr. Rashevsky will turn to the nature of time.

Accordingly the bending will not alter the theorems of plane geometry as applied to the triangle. The sum of its angles still equals 180 degrees; the sum of the squares of the two sides (if it be a right triangle) still equals the square of the hypotenuse. In general, the geometry of a curved surface produced by undistorted bending of a sheet of paper remains the same as the geometry of a plane. Such a surface will be, in general, either a part of a cylinder or a part of a cone.

But it is impossible to produce *every* kind of curved surface by bending a sheet of paper into the proper shape. Figure 6 demonstrates, for example, that it is impossible to spread this sheet of paper smoothly over the surface of a sphere.

It will be otherwise, however, if instead of the sheet of paper we take a sheet of *rubber*. The rubber will stretch. With sufficient patience we can spread the rubber quite smoothly over the sphere of Figure 6. The reason is that the rubber has been *distorted*; some parts of the original rubber plane have had their dimensions altered and this alteration of the dimensions has occurred in different degree in different parts of the rubber sheet.

If we lay out this sheet of rubber on a flat surface and draw on it the figures of plane geometry—triangles, rectangles, straight lines and others—and if then we wrap the rubber smoothly around the sphere, we will find that the figures on the rubber *no longer obey the rules of Euclid's plane geometry*. The straight line *AB* will not remain of the same length; the angles of the triangle will no longer total 180 degrees; the theorem about the sums of the squares of the sides equalling the square of the hypotenuse will no longer hold.

By bending the rubber around the sphere we have stretched it differently in different parts. In a word, we have *distorted* it. And along with it we have distorted the geometry of the figures that were on it.

Thus we obtain simple and conclusive evidence of a fundamental idea in geometry, the idea that the geometry of the surface of a sphere is not the same as the geometry of a plane. Even the simple rules about straight lines will not hold for the surface of a sphere. It is impossible to draw a straight line on the surface of a sphere at all.

There are, it is true, certain lines on a sphere which have some of the properties of a straight line. For example, there are the "great circles," the lines which resemble straight lines in being the shortest distance between two points. These great circles are illustrated by Figure 7. Out of three of these great circle lines we may construct a spherical triangle, as is illustrated by *ABC* on Figure 7. These will have *some* of the properties of plane triangles but not all of them. For example, the sum of all the angles will not equal 180 degrees.

All this is expressed by saying that the rules of ordinary plane geometry do not apply to figures drawn on the surface of a sphere. Or, in the more customary statement, "the geometry of a spherical surface is *non-Euclidean*." It does not obey the theorems laid down by Euclid.

There exists, in fact, an infinite number of curved surfaces analogous to the surface of a sphere. One of them is the surface of an egg, another is the surface of an onion or of a rounded doorknob, still another is the surface of a pear. For each of these the theorems of geometry would differ. The relations between triangles, rectangles or other figures will not be the same, depending upon the exact shapes and properties of the surfaces upon which they are inscribed.

We arrive, then, at a very important and far-reaching conclusion. It is this. There exists an infinite number of possible curved surfaces and, so far as concerns the relations of figures like triangles and the like, there must exist, therefore, an infinite number of possible non-Euclidean geometries; all different but all true, each one for the particular curved surface to which it applies.

This notion of non-Euclidean geometries, each depending upon the surface to which it is suited, was extended by N. J. Lobatshevsky, B. Reimann and other famous geometers to *three*-dimensional space. They imagined possible geometries where the relations between figures *in space* might be different in the different geometries, just as are the relations between the two-dimensional surface figures inscribed on differently curved surfaces like eggs and pears and spheres.

At first sight it may seem to one that this is a mere

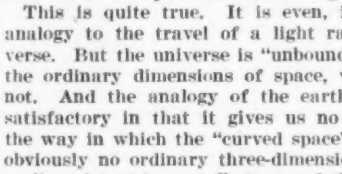


Fig. 1: Demonstrating the angle-sum of a triangle to be 180° in a Euclidean plane

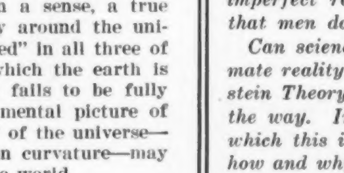


Fig. 2: Illustrating the Pythagorean theorem connecting the three sides of a right triangle

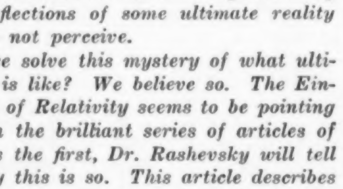


Fig. 3: Displaying the analogue, for three dimensions, of the Pythagorean relation

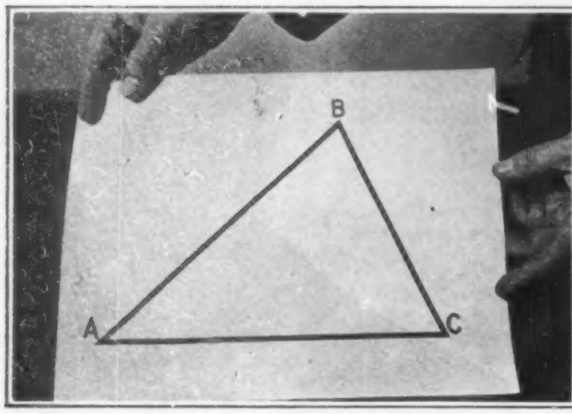


Fig. 4: The familiar triangle, simplest case of a "plane figure," and the Euclidean plane in which it lies

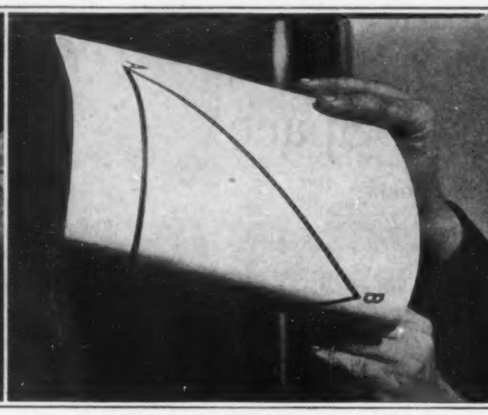


Fig. 5: Without distortion it can be made to fit upon certain types of curved surfaces—the cylinder, for instance

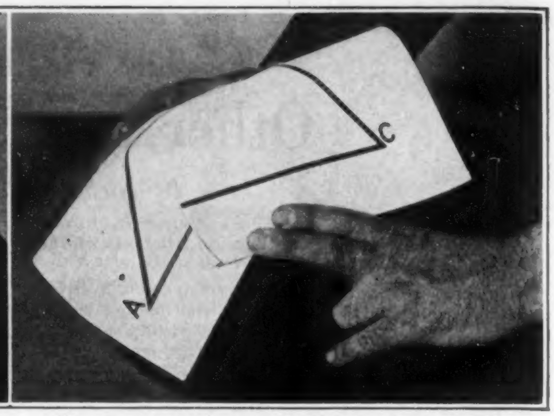


Fig. 6: But when we try to apply it to other surfaces—such as the sphere—we cannot do so without crumpling or tearing it

abstract speculation, having no concrete and picturable meaning. But this is not true. It is just as possible to represent to oneself the existence of a non-Euclidean *space* as it is possible to represent (as we have just seen) the existence of a non-Euclidean *surface*. The only difficulty lies in the correct understanding of what is meant by a non-Euclidean space.

The principles of plane geometry, as we study them in school, are deduced from a set of simple, obvious relations that we call axioms. But we can verify these axioms, if we like, just as we can verify the relation between the slides and the hypotenuse of a right angle triangle; namely by measuring them with a ruler. We can do this, that is, within the limit of accuracy of our ruler. If the figures come out not quite right we say that the ruler was a little inaccurate or that we took one or another of the measurements more or less incorrectly.

We have agreed, that is, that in case of any discrepancy between the results of actual measurements and the logical principles of Euclid's geometry, we will say that the geometry is right and that the measurements are wrong—or, as we more commonly say, that the measurements are "inaccurate."

This is a very important point and one that it is essential to grasp clearly and definitely. By general human agreement *geometry is always right.*

If a surveyor measures the three sides of a field which is shaped like a right-angled triangle and if he finds that his figures do not agree with the theorem about the squares of the sides and the square of the hypotenuse, he does not conclude that something has gone wrong with geometry. On the contrary, he assumes that something has gone wrong with his measurements.

These measurements depend, in the last analysis, on the chains or tapes or rules that he uses to measure with; that is, on his measuring rods. These may be imperfect. But what, then, is a "perfect" measuring rod? Since we have agreed that if the measurements do not agree with the Euclidean geometry it is the measurements and not the geometry that must be wrong, there exists, quite obviously, only one possible definition of a "perfect" measuring rod. It is one that fits the Euclidean geometry.

If we wandered, by accident, into a region of the universe where the Euclidean geometry was not in force—in quite the same way as when a rubber plane which is Euclidean is bent around a sphere that is not Euclidean—then we would never know that our *geometry* had gone back on us. We would think simply, that our *measuring rods* had gone back on us.

And it is quite possible that we are in such a part of the universe now. It is probable, even, that in every part of the universe our measuring rods will not *quite* correspond to the requirements of the Euclidean geometry.

It is probable, in a word, that real space—the space that constitutes this actual universe of ours—is not quite the same as the space which Euclid assumed. To return to the idea of the rubber sheet stretched over the sphere, we may be in a real space in which the ordinary theorems of geometry are very slightly distorted, just as the rubber sheet would be if it were laid down smoothly on the surface of a sphere of very large radius and very small, but still perceptible, surface curvature.

To see how this might be possible without its being apparent to our senses or to ordinary measurements let us consider an example formulated by the great French mathematician, M. Henri Poincaré.

Let us imagine, said Poincaré, a fictitious world inclosed inside a sphere of limited radius. Let us imagine this fictitious world to have the following properties. The temperature at the center of the world-sphere has a definite value, say 0 degrees, Centigrade. This temperature decreases continually from the center of the sphere to its periphery, so that at the outer boundary of the sphere the temperature is the so-called absolute zero of 273 degrees below zero, Centigrade.

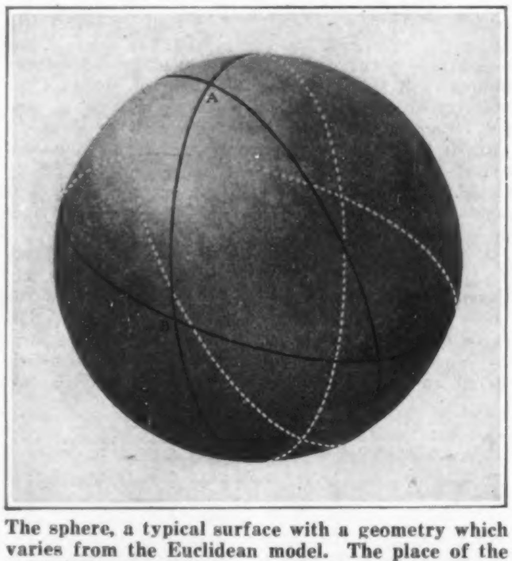
Now let us assume that all the bodies in this fictitious world expand and contract in response to temperature and do so all in exactly the same way. Let them all contract by 1/273 of their dimensions at zero Centigrade whenever their temperature is lowered by one degree. Then at the center of the sphere all bodies will have their maximum dimensions and at the periphery of the sphere all bodies will shrink to points and have no "dimensions" at all.

And finally, as an ultimate step of fantasy, let us assume that this world is inhabited by thinking creatures subject to this same law of contraction and expansion with the temperature. If such an inhabitant moves from the center of his world toward its periphery he will decrease in size. But he will not know that he is decreasing in size. Why not? Because every body of whatsoever nature that he carries with him or that he encounters on his journey will be decreasing in exactly the same ratio.

The sizes of *all* bodies will depend on their distance from the center of the world. This being so, no one could ever know that any of the bodies altered in size at all.

But suppose that an inhabitant of this fictitious world discovered in some way, that his measurements made on a larger scale disagreed with the rules of the Euclidean geometry. Would he say, then, that the "sizes" of things differed with their position in space? He would not. He would possess no definition of absolute size by which to determine the size of his objects at different places.

What he would do, in fact, would be to decide that



The sphere, a typical surface with a geometry which varies from the Euclidean model. The place of the straight line in the plane is here filled by the great circles, of which three are shown; and just as three lines in a plane form a triangle, so do the three great circles. But it is not a plane triangle, and its angle sum is greater than 180 degrees

his geometry was at fault. He would conclude that the properties of his particular world—the properties, that is of the "space" which his particular world comprised—were not the properties of Euclidean space. He would construct for his real space, or for the space which seemed to him the closest to reality for his particular world, a new and non-Euclidean geometry especially designed for that particular space.

This particular non-Euclidean world imagined by Poincaré has a property that is of especial interest to the present inquiry. It would seem to its inhabitants to be infinite. An inhabitant moving away from the center of this world toward its periphery would become smaller and smaller. His steps would grow shorter and shorter. If he could reach the actual boundary of his world he would shrink to a point. But he would never know that he was shrinking. It would seem to him that he took equal steps; that he went on for an eternity, ever farther from the center of his world, ever deeper into the void of outer space.

Actually he would be approaching a limit which he would never reach, the periphery of this world. To himself it would seem that he was advancing steadily into an utterly unlimited infinity.

This example illustrates a variety of possible non-Euclidean spaces which would seem (to the inhabitants) to be infinite, although actually enclosed within a finite sphere. They would be "infinite but limited." The next example, one occasionally used by Professor Einstein, illustrates another kind of possible non-Euclidean space; one that seems to its inhabitants to be finite, although really it is unlimited.

We will consider, first, a two-dimensional illustration; one concerned with surfaces and with creatures that live on surfaces.

Imagine a great glass sphere, resting on an infinite plane and with a source of light at the top of the sphere, all as illustrated in Figure 8. Imagine the surface of this glass sphere to be inhabited by flat, triangular creatures who can move at will over the surface of the sphere without altering their shapes. They are illustrated by the black triangles of Figure 8. The geometry of these creatures will be a two-dimensional geometry but it will not be a Euclidean geometry, for we have seen already, from our illustration of the distorted rubber sheet, that the geometry of spherical surfaces is not a Euclidean geometry.

Now let us imagine that the *shadows* cast by these flat, sphere-surface creatures on the infinite plane below the sphere are themselves living creatures, who imagine that they move over the plane which they inhabit according to their own wills, instead of at the wills of the creatures on the sphere above. Suppose, too, that *everything* which exists on this infinite plane is really nothing else than the shadow of something that has a real existence on the surface of the sphere above it. Our plane will be, then, not unlike what certain mystics have supposed this terrestrial world of our own to be—a mere shadow of some other world, to us unknown. Everything on the plane, however real in semblance, will be merely the shadow of an unknowable reality existing somewhere else.

What will be, then, the appearance of their "space" to the shadow-creatures who dwell, imagining themselves free-willed and individual, on this infinite plane of shades and illusions?

As one of these shadow-creatures moves outward from the point where the glass sphere rests, toward the periphery of his plane-world, he will increase in size. But so will everything about him increase in size. All these things, remember, are but shadows, just as he is. Accordingly the shadow-creature will not sus-

pect that anything has changed. It will seem to him that he advances toward a limit which seems to him the boundary of his world, but which is determined, in fact, by the approach, of the real sphere-surface creature above him, to the point just underneath the source of light on top of the sphere.

As this point is approached the shadow-creature below approaches an infinite distance from the sphere. Also he approaches an infinite size for himself. It seems to him, therefore, that the plane on which he dwells is not infinite but limited.

To look at it in another way, it is obvious that the number of shadow creatures who can exist on the *infinite* plane is limited by the number of real shadow-forming creatures who can find room on the *limited* sphere above. This number, of course, is finite. We have then a two-dimensional model in which an infinite plane appears to its two-dimensional inhabitants to be limited.

It is equally possible to extend this illustration to a three-dimensional world. All one has to do is to imagine a fictitious world like that of Henri Poincaré which we examined above, but one in which the inhabitants *increase* in size as they go out from the center of their world instead of decreasing; this increase being controlled by the same law that applies to the shadow-creatures moving outward on their plane.

This would provide us with a space (not merely a plane) which would seem to its inhabitants to be finite although from our point of view it was unlimited. This would be, you observe, exactly the reverse of the world imagined by Poincaré.

The characteristic thing about both of these fictitious worlds is that they seem to their inhabitants to be not what they seem to us. One of them seems infinite; we, looking at it from the outside, see that it is really finite. The other world seems to its inhabitants to be finite. We see that it is infinite.

We are brought to an interesting question. How much do we know about our own world; about the so-called "real" universe in which we live, into the depths of which we look out whenever we see a star?

This brings us back to our problem of the nature of space. It is obvious, after the illustrations that we have described, that there can be many kinds of space. It is obvious that these other kinds of space do not obey the theorems of Euclid, they are non-Euclidean.

In his General Theory of Relativity, Einstein was led to assume that the space of the real universe is, in fact, non-Euclidean. We have seen in this article that this is quite possible. There can be an infinite number of different varieties of space, each with its own special and different geometry. The discovery of the peculiarities of a single variety of space may be, to dwellers within that variety of space, an extremely difficult matter.

The relativity theory does permit us, however, some deductions about the nature of the space that we live in and about the "curvature" of this space—this "curvature" being, in one sense, a measure of the degree to which the space departs from strict Euclidean properties. More important still, the relativity theory permits some deductions about the probable nature of that ultimate reality which lies, we believe, back of all the ideas which we call by such names as space and time and matter. To explain the nature and basis of some of these deductions will be the purpose of the future articles of this series.

Is Time the Fourth Dimension?
This question will be discussed in Dr. Rashevsky's next article—in the December number.

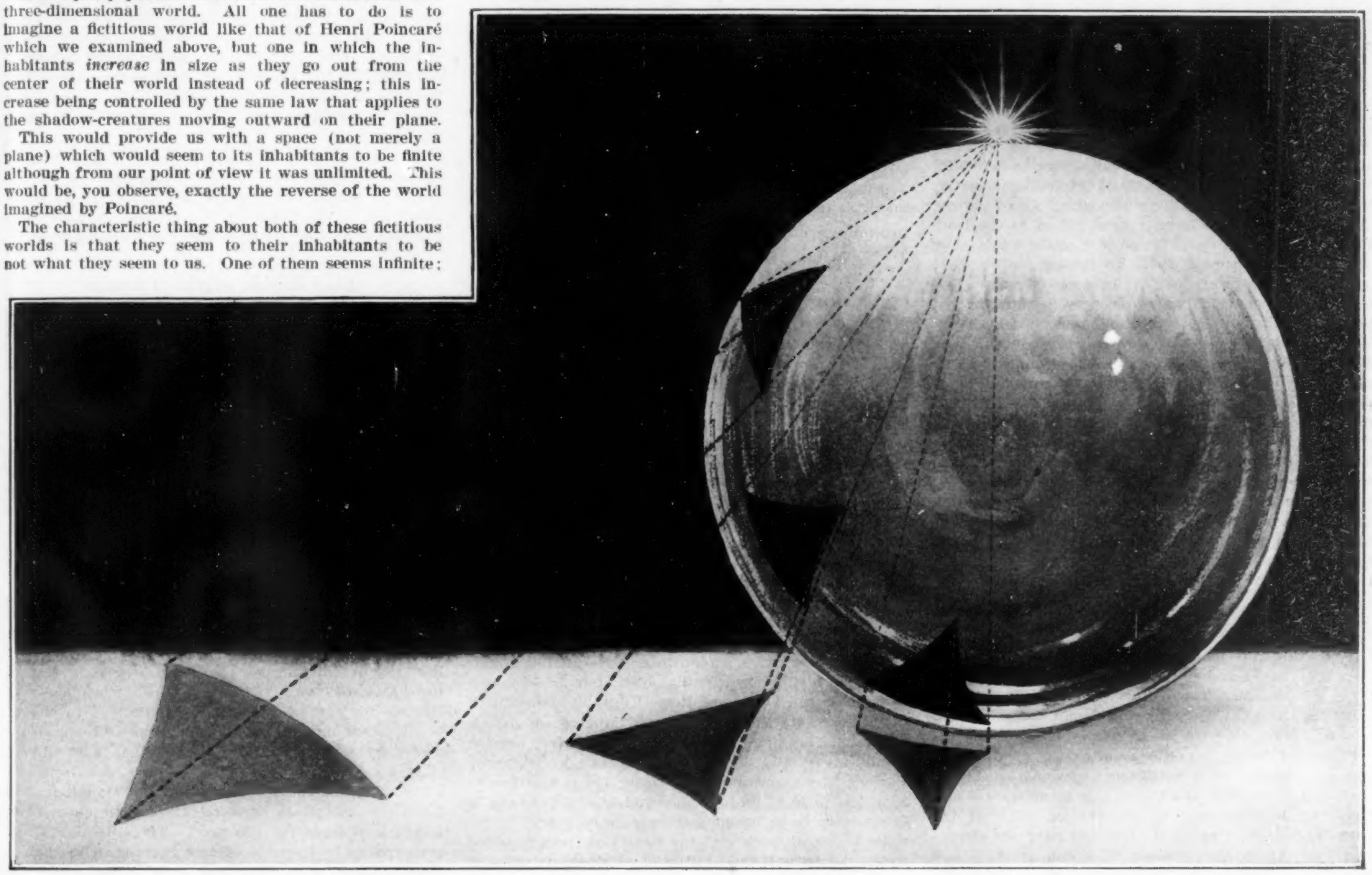


Fig. 8: The plane is of infinite extent; the sphere is finite and unbounded; yet, as the figure illustrates, there is an exact point-to-point correspondence between the two, so that intelligent beings living in either might mistake it for a surface of the other type. The meaning of this model is discussed fully in Dr. Rashevsky's text

Auroral Spectrum and Upper Atmosphere

THE aurora borealis is produced by the action of electric radiation from outer space upon the upper atmosphere. Height measurements have shown that such radiation usually penetrates to a height of 100-105 km. Most auroral forms have their maximum light intensity at a height of 10-20 km. from the bottom edge, and by far the greater part of the light emitted from the aurora comes from a height interval of 100-130 km. The upper limit varies very much. Usually we can only follow an aurora up to an altitude of 130-150 km., but the ray-forms may be seen much higher. The greatest altitude at which isolated auroral "rays" may appear seems to increase toward lower latitudes. Near the auroral zone no rays are observed higher than 300-350 km.

Practically all auroral light is emitted from the matter present in the atmosphere, and not from the carriers of the cosmic rays; for none of the principal lines in the auroral spectrum shows any Doppler effect. The character of the light must be a function of the electric radiation and the constitution of the upper air.

In 1912-13 Professor Vegard of the University of Christiania commenced observations on the auroral spectrum, using a spectrograph of high light power with considerable dispersion, and a spectroscope. With the spectroscope he observed the prominent green line, and his observations gave $\lambda = 5577$. With the spectrograph he obtained the green line and six lines in the blue and violet. The latter were found to be identical with prominent lines in the negative band spectrum of nitrogen. Although the stronger lines in the auroral spectrum were greatly overexposed, no trace of hydrogen or helium was found. The view previously current that the atmosphere above 100 km. should mainly consist of light gases had, therefore, to be abandoned. By comparing the intensity of the green line with that of the known nitrogen lines of the auroral spectrum on spectrograms corresponding to the lower and upper limit of radiant aurora, it was shown not only that the green line, as well as the open lines of the spectrum, belong to nitrogen, but also that there are special physical conditions in the auroral region, namely that the typical auroral spectrum is emitted from solid nitrogen.

To test this hypothesis more directly, Professor Vegard, working with Professor Kammerlingh-Onnes at the latter's famous low-temperature laboratory at the University of Leyden, in Holland, devised a method of producing thin films of frozen, solid nitrogen and of exposing these films to electric radiation so that a glow spectrum was obtained.

As was expected, this spectrum contained the familiar green line often identified in the light of the aurora, a line that many previous investigators have been inclined to ascribe to some unknown element present in the uppermost levels of the air.

By exposing the film of solid nitrogen to bombardment by the positively charged particles of the canal rays as well as by negatively charged electrons, Professor Vegard was able to elicit, also, additional spectrum lines frequently observed in the aurora. These two spectrum bands are apparently identical with those observed in the spectrum of the night sky.—*Abstract from Nature, May 17, 1924 and September 6, 1924.*

Our Point of View

Our Destiny

AS A journal devoted to the interests of science and industry we cannot let the month pass by without some reference to that great work of adjustment and reconciliation—the acceptance of the Dawes' plan for the settlement of reparations. Upon this foundation it will be possible to rebuild the financial and industrial structure of Europe. Good faith, patience, and untiring industry, with just a touch of optimism, will see the thing through. Given these, and the world may come back to normal far more rapidly than even the most hopeful among us believe.

That this gathering of hostile nations for a rational discussion of problems which seemed to be impossible of adjustment should have resulted in their amicable solution is proof that peace hath her victories no less than war. It is a source of deep gratification to us, as it must be to every American, that, as we were helpful in winning the war, so, in equal if not greater measure, we have helped to win the peace.

Destiny has called these United States to the leading position among the great peoples of the earth. For what purpose—to what end? To the end, surely, that we carry on the great work of disinterested cooperation and conciliation which was so successfully inaugurated at the Washington Conference and repeated, five years later, in this other great conference in London. For such a task we are most happily circumstanced. Our geographical situation relieves us from any fear of attack. Our vast domain, our wealth, the universal prosperity of our people, and our unbroken record as a peaceable and peace-loving race, relieve us of any suspicion of warlike and aggressive aims. We have won the confidence of the world, and in winning that we have won a priceless possession. For, from this vantage ground, we may become the principal agent in bringing the nations of the world to substitute reason for prejudice, and the calm discussion of the conference table for the wild fury of the battlefield.

Preparedness is Not Militarism

A GREAT many well-meaning people confuse naval and military preparedness with militarism. They decried the United States Army's "Defense Day" movement of last month; they look with grave misgiving upon the observance of Navy Day this month. To such worthy souls, a warship or a soldier is alike anathema; for each is the "outward and visible sign of an inward and spiritual" bedevilment. In the twisted mind of the so-called pacifist, a national army and navy are always and everywhere the symbols of greed, tyranny and brute force, destined to breed vainglory at home and hatred abroad.

To a well-balanced mind an army and navy appear to be as necessary for the safety and well-being of the nation as a police force is for the protection of a municipality. The navy on the high seas and the army on land safeguard the nation and its nationals, in the selfsame spirit as the policeman on his beat safeguards the city and the people that dwell therein.

If New York adds 5,000 men to its police force, does Newark or Philadelphia protest that its own safety is prejudiced? Does a shakeup and redistribution of the police force of Cleveland in the interests of efficiency cause unrest in Detroit or Cincinnati?

The SCIENTIFIC AMERICAN has always been a strong advocate of naval and military preparedness and always will be. So far as the Navy is concerned, we believe that its personnel, officers and men alike, should cease all criticism of the Treaty and bend their energies to keeping our fleet up to parity with that of Great Britain, and that both nations should loyally abide by the provisions so wisely laid down at the Washington Conference. To do this will cost money—very large sums of money—and it is the duty of Congress to vote loyally such appropriations as are suggested by the General Board of the Navy. The Washington Treaty with its 5-5-3 ratio is one of the most laudable and productive instruments of peace that the world has ever seen. Let us be loyal to it and its provisions, and see to it that we maintain the 5-5-3 ratio, not only in battleship strength but also by building such cruisers, submarines, etc., as the General Board of the Navy may suggest.

Defense Day, as observed by the Army last month, was a movement for peace. Certainly it was in no sense militaristic. Billions of money were needlessly sacrificed in the World War, because when war broke we were utterly unprepared. Overnight, we had to find out which firms could make what. Not only was the process slow and very costly, but it resulted in a frightful disorganization of our industrial balance, from which we have not even yet recovered. Defense Day was a test of the economic mobilization of the manufacturing resources of the nation. We do not wish war; it is utterly abhorrent to us; but if it has to be, we wish to be prepared to jump in at once with all our might and finish it up with the least possible expenditure of time, blood and treasure.

Must History Be Re-Written?

THE astonishing results which are attending the efforts of the archeologist and the explorer may, and indeed must, call for the re-writing of certain phases, if not whole periods, of the world's history. Following closely upon the dramatic disclosures of the tomb of Tutankhamen, the world has been startled by the scarcely less important finds in Palestine and Asia Minor, to say nothing of those on our own continent. And now comes a young Italian professor with an astonishing but apparently well-attested story of the finding among the musty and neglected records of an Italian monastery of the whole one hundred and forty-two volumes of Livy's history of Rome, of which less than forty were supposed to be in existence.

Gibbon's monumental work will be unaffected by this discovery; for his "Decline and Fall of the Roman Empire" commences at the highest points of Rome's imperial power and splendor under the Antonines. But if Livy's history has really been found, Ferrero's "Greatness and Decline of Rome," dealing mainly with the Caesars, and particularly with the great Augustus, will stand, if not for revision, at least for a very notable amplification and enrichment. Although Professor Ferrero is well advanced in years, his pen seems to have lost none of its brilliance and fascination, and it is sincerely to be hoped that he may be spared to re-write his great work with the wealth of fresh material which the great Roman historian of nineteen centuries ago has possibly placed at his command.

Livy was very human, and here and there in his letters we find touches of sentiment and humor that have a very modern flavor. It is not unlikely that his full history will afford those intimate, personal glimpses of the private life and character of the early Romans, which, after all, are, perhaps, the most alluring, if too infrequent, feature of ancient history.

The Man Behind the Machine

IT IS no disparagement of the excellent Douglas biplanes that carried our airmen on their 25,000-mile circumnavigation around the globe, to give the place of honor to the intrepid pilots, Smith and Nelson. The machines that landed on our eastern coast were not literally the same that left our western coast some five months ago on their great adventure. Structural repairs calling for new material and many substitutions of new engines were made during this long-drawn-out flight; for this, in the present state of the art, is an element of the technique of military and commercial flying in any part of the world. The supreme achievement was that of the man behind the machine; for the two army fliers that came through were the same that set out, nearly half a year before, on a venture which ninety-nine men out of a hundred believed to be impossible of fulfilment.

But the thing has been done, and we venture to affirm that as a feat of combined courage, skill and physical endurance, it stands unsurpassed in the world's age-long story of adventuresome travel. And we say this with a full appreciation of the elaborate provision made by the United States Army and Navy, in the way of bases, landings, weather forecasts, and guide ships strung out along the course. Granting all this—and it was absolutely necessary in the present state of the art—this first aerial navigation of the globe is a milestone in the progress of aeronautics, whose importance is attested by the enthusiasm with which our airmen were welcomed in every country over which they flew.

And it may well be that not a little of this spontaneous outburst was due to an appreciation of the fitness of things, that the first navigation of the earth should be accomplished by the country in which mechanical flight had its birth and early development.

Blue Ribbon of the Atlantic

THE announcement that the "Mauretania," that veteran of the transatlantic service, had broken her own long-standing record for the eastward passage, must have brought a thrill of pleasure to many a traveler across the western ocean. Fourteen years ago this same ship, then a coal burner, made the run over the old and shorter route, New York to Queenstown, in 4 days, 10 hours, and 41 minutes at an average speed of 26.06 knots. With her ill-fated sister, the "Lusitania," she had the distinction of being the first high-speed liner to be driven by the then comparatively new steam turbine, and it was the sensational speed and reliable running of these two Cunarders that brought about the universal adoption of the turbine in high-speed liners.

Sixteen years of continuous service had played havoc with the blading of the "Mauretania's" turbines, and before she went out of service last year, she was hard put to it to hold her own with those giant vessels, the "Majestic" and "Leviathan." So when she was laid off for turbine repairs, it was decided to change her bunkers into oil tanks and replace the fireman's shovel by the oil spray. This change, it should be understood, does not mean an increase in horsepower, which still remains at the original 70,000; but it does mean that the steam pressure can be maintained uninterruptedly from port to port. There is no fall of pressure, as in the case of coal burning, when half a dozen boilers at a time lose their steam while the firedoors are open and clinkers are being cleaned out of the grates. Rebladed and oil-fired, the breaking of her long-standing record was to be expected, and an analysis of her record trip of 5 days 1 hour and 49 minutes to Cherbourg shows that, under favorable conditions of wind and sea, the "Mauretania" is due to cut the time below five days. On the third day out she averaged 27.04 knots, and on the last day she ran the 189 miles from Bishop's Rock to Cherbourg at an average speed of 27.72 knots, the tide, of course, being in her favor. As we go to press word comes of another record, made between New York and Plymouth, of 4 days 21 hours and 57 minutes. On this occasion letters mailed in New York were delivered in London within six days.

And what of the future? Shall we see the 30-knot liner? It is unlikely, at least with steam propulsion. The "Mauretania," finely molded as a yacht and crammed with engines and boilers, is the last of her type. The heavy-oil engine is coming along fast; and because of its great economy in space, weight and fuel, it may well reach the point at which a 30-knot oil-engined liner will prove an attractive proposition to the transatlantic ship owner.

Here and There

Father Francis A. Tondorf

SCIENCE gets into the news of the day far more extensively than it used to; and one of the most mentioned scientific establishments is the Georgetown University Observatory, which occupies a place of eminent respectability in the field of astronomy, and one of great distinction in the narrower business of recording earthquakes. Much of the responsibility for this may be credited to Father Francis A. Tondorf, chief seismologist at Georgetown. He is pictured herewith, accompanied by his recently developed vertical seismograph. With this instrument he says that he will be able to record more quakes than have heretofore left their autographs in his hands, and also that because of his improved method of registering his information it will get across to the public more promptly, more fully, and in more readily available shape. Our readers will probably realize that most of the items which they see in the daily press with reference to observations of earthquakes so many miles out to sea in this, that or the other quarter come from Washington, and have been made with the Georgetown apparatus. More than most scientists, Father Tondorf is the designer of the instruments which he uses in his daily routine.

A SLIP of the editorial typewriter which occurred on our editorial page for June was so obvious that most of our readers must have corrected it mentally while reading the sentence in which it occurred; yet we feel that it merits recognition and formal correction. We were pointing out the success with which the provisions made for flood control in the Panama Canal had functioned in the unprecedented high-water period of the past spring, and reverting to the arguments advanced in favor of sea-level and of lock canals at the time of construction. Plainly enough, the ability of the existing canal to take care of the greatest flood to which it has been subjected is testimony as to the soundness of its engineering, and we assume that all our readers know that it is a lock canal and not a sea-level one. But through some aberration of original dictation or of composition and proof-reading we credited this testimonial to the sea-level canal which does not exist.

Col. Jay J. Morrow

AMONG those to call our attention to the misprint was Col. Jay J. Morrow, Governor of the Canal. We take this opportunity not merely to acknowledge the correction and the error to which it pertains, but to present the portrait of Col. Morrow as that of a very efficient military administrator and (on the face of the evidence) a reader of the SCIENTIFIC AMERICAN. At various times during his active Army career Col. Morrow has been assigned to administrative duties, first in the Philippines and later (more than once) in Panama. His various terms as Acting Governor in the latter territory culminated in his actual assumption of the Governorship in March, 1921, and he has held it ever since, though retired from active Army service at his own request in August, 1922. Col. Morrow is typical of the American school of military civil administration.

Dr. Miethe, of gold-mercury fame

THERE will be no conceivable question in the mind of any reader as to the nationality of the formidable countenance at the lower left corner of the page. This face could not possibly be other than that of some Herr Professor. It is in fact that of the worthy Dr. Miethe, of the Technische Hochschule, of Berlin, who has broken into print lately as the discoverer of a method of extracting gold from mercury. It is an interesting mark of the extraordinary overturn which the fundamentals of physical science have undergone, that where twenty years ago this claim would have been met with scoffing references to medieval alchemy, today we all take it as a matter of course that it should be intrinsically possible to convert mercury into gold, so that the only raising of eyebrows which we do in the presence of Dr. Miethe's claims is with reference to their commercial practicability. Here skepticism is amply justified, so far as his present showing is concerned, for one account carries the confession that the recovery of a dollar's worth of gold after his technique costs no less than $60,000. Apparently he has some distance to go before he reaches the stock-selling stage; and in fact, we carry his picture, and refer to his work, merely by way of emphasizing the fact that any twentieth century physicist would expect him to get some gold out of mercury, if the cost of the work is no factor.

Paul Sollenberger

ONE of the routine tasks of science to which the layman gives perhaps less thought than it deserves is the determination of the exact time. We set our watches by the Western Union ball or by the clock in the jeweler's window, with little or no knowledge of just how and why we may be so confident that it is exactly noon when this authority tells us so. One reason why we may have this confidence is pictured herewith—Paul Sollenberger, member of the astronomical staff at the United States Naval Observatory. He in fact is the man who actually tells the world when it is noon. The cylinder at which he is standing in the picture is a chronograph connected with the Observatory's standard clock, kept in a triple vault far underground, where there is no vibration and no dust, and where the temperature never varies by even the fraction of a degree. At 11:55 by the chronograph, Mr. Sollenberger closes the switch in the circuit that ticks off the seconds for the ensuing five minutes all over the country. The pause just before the critical instant, the final signal that marks the arrival of this instant, are likewise of his making; then he is through with his public contact—for another twenty-four hours.

ALIKE in pulpit and in laboratory, much attention is being given these days to the doctrines of evolution. And, of course, the problem gets broader and broader the longer we consider it. A rather unusual viewpoint is that of Kirtley F. Mather, Professor of Geology at Dennison University, whose portrait heads the third column. Prof. Mather recently got his name in the papers in connection with his remarks at a gathering of the National Academy of Science. He declares that science and history join in showing that life does not progress from simple to complex, or from lowly organisms to higher types, or from primitive to civilized conditions, as a natural and necessary thing. He pictures the belief in such progress as a naïveté, a translation into modern language and modern thought of the same ideas that led the Greeks to picture the heavenly bodies as moving in circles because the circle was what they regarded as the perfect figure—a fathering of the thought by the wish, in other words. Prof. Mather believes that in the natural course of events a lot of good things go bad, and a lot of bad things are made good; and he pictures the environment as the cause, largely accidental, of all this. Incidentally, just by way of demonstrating that he is a thorough-going scientific iconoclast, he denies that other heavenly bodies than the earth are inhabited, insisting that the life on the earth is unique in time and in space. We present his views and his face, of course, not at all in endorsement, but merely because both of them are interesting and will attract attention.

Prof. Kirtley F. Mather

THE Centenary of the Franklin Institute, celebrated on September 17, brought forward some addresses of extraordinary interest from gentlemen who are in a position to tell us something about the character of the next war, if there comes such a calamity. Gen. Squier, universally known for his work in the Signal Corps, told his audience of an anesthetic gas, developed to replace poison gas, which would be available in sufficient quantity to be used from airplanes against the entire civil population of a combatant nation. Thus scattered, it would put the nation to sleep as one man for a period of two days, after which they would wake up, presumably, to find themselves conquered and occupied by a hostile gas-masked force. Gen. Patrick, Chief of the Army Air Service, talking about riderless planes piloted in swarms by a single controller at a distant point, aerial cameras that nullify camouflage, and bombs that would wipe out a battleship with a single hit, expressed the belief that what we did in 1918 can never be done again—that the transportation of any considerable expeditionary force across the seas has become an utter impossibility. Meanwhile it is announced that there is to be staged soon at the Aberdeen Proving Ground a special demonstration of these terrible agents of modern warfare, some of the American engineering societies being the guests.

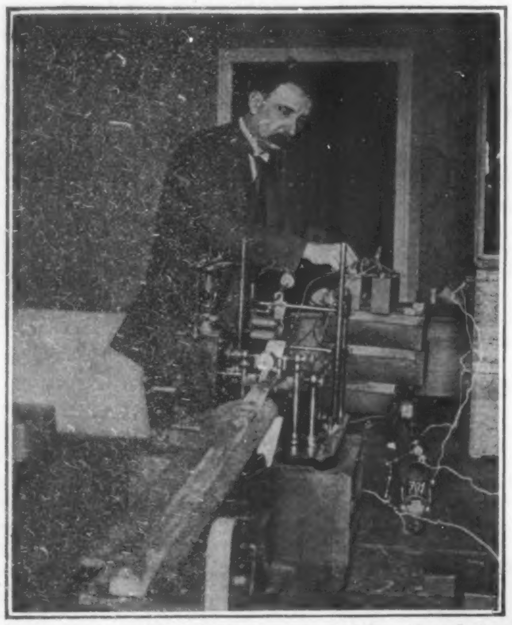
INTERESTING figures of contemporary scientific work are not necessarily of the male persuasion. And if, as Kipling insists, the other sex is the deadlier, it is also capable of good work in the direction of beneficent scientific effort. The young lady whose portrait adjoins, for instance, is a member of the staff of the New York City Board of Health; and one of her particular duties is seeing that the water that washes the New York beaches is fit also to wash the New York bathers. The procedure is the more or less familiar one of making culture tests to determine the bacterial content of the waters; and when Dr. Hadfield doesn't like what she finds in them, she is apt to order up the "No Bathing" signs until the cause is isolated and eliminated. This has reference, of course, to the presence of actual pathogenic organisms, and not merely to that of floating garbage, brought back to shore by adverse currents from barges that did not go far enough to sea. It doesn't take the Board of Health to find pollution of the latter character, as indignant letters from the Jersey shore resorts demonstrate from time to time whenever they reach the editorial desk.

Dr. Hazel M. Hadfield

Listening to the Stars

How the Night Skies Regulate the Clocks of France, Without the Aid of Any Human Hand

By Frederic M. Delano, Jr.



M. Jouaust in his laboratory, assembling the photo-electric apparatus for converting light into sound

INTO the radio receiver of every Frenchman there is about to come the music of the spheres. At last the morning stars will sing together so that we can hear them. The stately procession of those celestial light specks as they march by overhead will come to us audibly.

And this masterpiece of scientific poesy the Frenchman, always practical, will put to work to set his clocks.

Suppose, a few months from now, that you are listening at your radio receiver somewhere in France for the nightly time signal from the great radio station of the Eiffel Tower. As the zero hour approaches you will hear in your telephone a clear musical note. That is the music of a star. At the exact second which marks the beginning of the new day that musical note will change sharply in tone. That tells you when to set your clock. The star that fixes the time for all France has gone, literally, under the wire.

This is the real purpose and accomplishment of the much-discussed new method of "hearing starlight" developed by two French scientists and radio experts, General Gustave Ferrié and Monsieur R. Jouaust. It is an improved method of fixing and distributing the standard time. Later, as we shall see, it may prove to be much more.

The standard time for all the world is set already by the stars but the method requires the intervention of a human watcher. An astronomer sits intently at his telescope. Across the axis of the instrument there runs a tiny wire, like the threads of spider web that cross the tube of a surveyor's transit. The astronomer has selected one star to watch. When this star crosses the fine wire in his telescope he presses a signal button. That determines the exact time instant by which the assistants in the observatory test and correct the readings of those marvelous standard clocks which regulate, in turn, the time of other clocks all over the world.

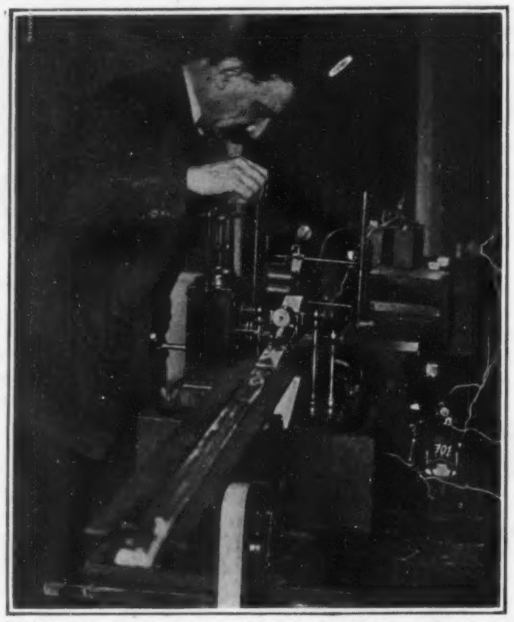
Thus the standard time for the United States is set at the Naval Observatory in Washington. In the same way the astronomers at Greenwich set the standard time for the British Empire. So the observers at Paris correct the time for France and those at Potsdam determine that for Germany. The final standard of time everywhere is the passage of some selected star across that fine wire in the telescope of the astronomer.

The difficulty about this has been the need of using the astronomer. The human body at its best is an uncertain and fallible instrument. Every astronomer possesses what is called his "personal equation," that is, the amount of time that he needs to see the star cross the wire, to understand that it has crossed and to press the button or give the other signal of some kind which says to the waiting clock that the star has done what was expected of it. These personal equations differ for different astronomers. They differ, even, for the same astronomer at different times, depending, for example, upon how sleepy he is or upon what he had for dinner.

Any scientific observation that depends upon the action of human senses and a human brain is necessarily fallible. Standard time has been such an observation. And standard time has always been, therefore, just a little bit uncertain.

The uncertainty amounts, of course, only to a small fraction of a second. For ordinary purposes it is unimportant. But there are many scientific purposes for which an exactly accurate standard time was very necessary. The exact determination of the slow wabble of the poles of the earth, the computation of the complexities in the motion of the moon, the precise investigation by radio time signals of the slow motions of parts of the earth's crust like the recently discovered northward slippage of the coast of California; these are some of the uses of standard time for which even a hundredth part of a second of inaccuracy is so important that it might be fatal to the whole investigation.

And so there has always been a demand from the astronomers and geographers for some direct method of fixing the standard time, some method of determining the exact instant of coincidence between the star and the wire without using the fallible and inaccurate eye or brain or finger of a man. It is such a method that General Ferrié and M. Jouaust have found.



This view gives a better idea of the apparatus and the way it is put together

They have devised an apparatus which converts the light of the star automatically into an electric signal. This signal is converted, also automatically, into a radio wave. Finally, this radio wave can be converted into sound or into a dot on a moving strip of paper or into a mechanical impulse that will itself correct the standard clock.

If one desires to do so, the radio wave can be converted into any kind of signal, practically without limit. Or it can be broadcast, still as a radio wave, to any part of the world to be picked up and heard or otherwise recorded in millions of radio receivers everywhere.

The signal of the passing star may come to every home.

General Ferrié and Monsieur Jouaust are models of that scientific modesty which is supposed to mark—and usually does mark—the scientist of real accomplishment. The whole achievement, says General Ferrié, is the work of Monsieur Jouaust. "On the contrary," said M. Jouaust when I called on him at his laboratory in the ancient buildings of the Paris Observatory, "the idea originated with General Ferrié. He has directed the work throughout. I have merely carried out what he wished to be done."

This is charming but unimportant. The chief fact is that between them these two remarkable and modest geniuses have given a great new scientific discovery to the world.

The hearing of the star begins with a device called a photo-electric cell. Scientists have known for some years that certain materials, among them the metal potassium, are able to give off small particles of electricity when they are illuminated by light.

Potassium is one of the most excitable of the chemical elements. It is so active that it instantly bursts into flame when it is exposed to the air. Water annoys it still more violently. In contact with this ubiquitous liquid a piece of potassium as large as a pea will make a burst of flame sufficient to set fire to the house.

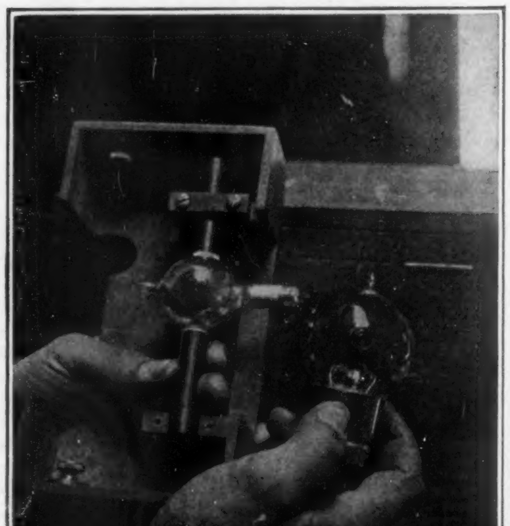
And so, when scientists use potassium for any purpose they seal it up inside glass bottles or cover it with layers of protective wax. In the photo-electric cell employed to hear the starlight, the potassium is contained inside an hermetically sealed glass bulb from which every possible bit of air has been carefully pumped out.

In place of the air, which would have combined with the potassium and set it on fire, there is introduced into the sealed bulb a small amount of one of the rare and inert gases, helium or argon. These gases are so inactive chemically that they will combine with nothing. In all the thousands of examinations of natural substances that have been made by chemists and in all the experiments made by scientists in the laboratory these gases have never been found in combined form. They are the invincible bachelors and old maids of chemistry.

The bulb for the starlight experiments contains, then, a tiny plate of metallic potassium protected by an atmosphere of these persistently inert gases; about the only kind of atmosphere, by the way, which the potassium cannot induce to combine with it. Into this cell, through a polished window on one side of the glass, there falls the ray of light from the star.

As this light ray hits the small potassium plate, some tiny particles of electricity—the particles called electrons—are driven off from the potassium. It is as though the bright ray of a searchlight swept over the surface of an ocean island at night, disturbing the thousands of birds that had settled down on it. These electrons fly out into the inert gas inside the tube and hit against the atoms of this gas.

Many of these atoms are slightly damaged. They become thereby conductors for electricity. The net effect is that an electric current from an outside source can now pass through the little glass bulb more easily than it could before. Inside the bulb, in addition to the plate of potassium and the inert gas, there is a metal ring connected to an electric battery. An



The photo-electric cell (left) and the two-grid tube, showing how the inner grid is contained in the outer, and both surrounded by the cylindrical plate

arrangement of outside apparatus also connected to this metal ring permits the measurement of the degree to which an electric current will now pass through the bulb.

All this takes place, you must remember, on an extremely minute scale. The tiny particles of electricity that fly off from the potassium plate when the light ray hits it are so small that something like a million million millions of them could crowd together not uncomfortably on the head of an ordinary pin. Even the atoms of the inert gas inside the bulb are only about a hundred times larger than this. The whole game of electric particles, atoms, electric currents and all of it takes place in a space not much larger than the head of a match.

Now we have the starlight converted successfully into an electric signal and brought outside the glass bulb of the small photo-electric cell. Here, in summary, is what has happened. The ray of light from the star has stirred up the particles of electricity to fly off from the potassium plate. These particles have hit against and damaged the atoms of the inert gas. These damaged atoms have effected the electric conductivity of the bulb. This change has been detected by the electric apparatus outside.

All this has happened in a time so trifling as to be negligible. The complete sequence of changes requires, so far as we can now determine, something like a millionth of a second.

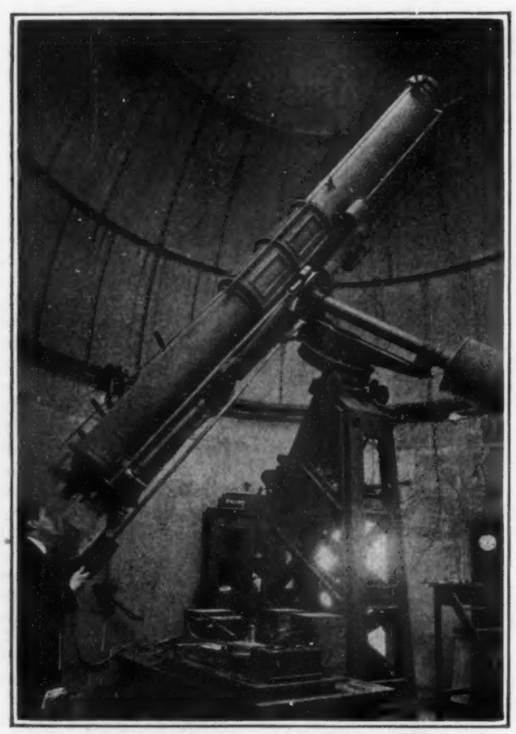
Now how is this applied to the sending out of time signals by radio?

The development of radio science to its present astonishing dimensions depends largely upon that remarkable invention, the vacuum tube. What the vacuum tube is, in essence, is a microscope for electricity. If you have a very tiny current of electricity, far too tiny to be measured in any ordinary way, you can apply this current to a vacuum tube and (provided that the electric current is an alternating one) the vacuum tube will magnify or "amplify" it just as a microscope will magnify some tiny object that you cannot see, for example an invisible disease germ.

This is what General Ferrié and M. Jouaust have done to the tiny electric current produced by the starlight in their photo-electric cell.

By using a series of vacuum tubes together with a more or less complicated radio apparatus of interest mainly to the radio engineer, they magnify the tiny starlight current until it is strong enough to be sent out over the radio in the usual way. The reconversion of these waves into sound, so that any French listener can hear them in his receiver, involves nothing novel. It is merely what is done every day in hearing the ordinary broadcasts.

The essential thing about the invention is the original conversion of the starlight into electric energy and then into the radio wave. The tiny photo-electric cell is the instrument upon which the stars will play the music that French radio listeners will hear.



Setting the telescope on the star. The various measuring instruments are seen on the table

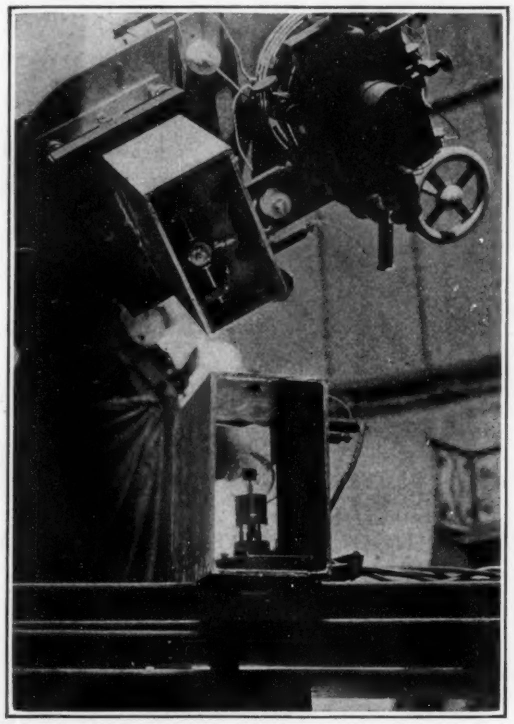
The application of this device to the practical measurement of time is quite simple. At the eyepiece of the telescope the living eye of an astronomer is replaced by the photo-electric cell. The telescope is pointed, as usual, at the desired star. The ray of light from the star then falls on the photo-electric cell just as it used to do on the retina of the astronomer's eye. The described sequence of electric changes then takes place and an audible note from the star is heard in the radio receiver.

Slowly the star moves across the field of the telescope, or to be more exact, the earth moves carrying the telescope with it so that the star *appears* to move across the telescopic field of view. Presently the image of the star approaches the cross wire stretched across the field.

As the star passes behind this wire, the light ray coming from it is cut off for a single instant. Immediately, the audible note of the radio receiver changes. That fixes, automatically and mechanically, the instant of passage of the star.

Thus far the utilization of the new device has actually been accomplished. The problem that General Ferrié and M. Jouaust set out to solve was how to determine standard time mechanically. It has been solved.

There remain, however, some extremely interesting possibilities for the use of similar methods in other ways. The essence of the new device is that it converts light into electricity. It is a new kind of energy converter.



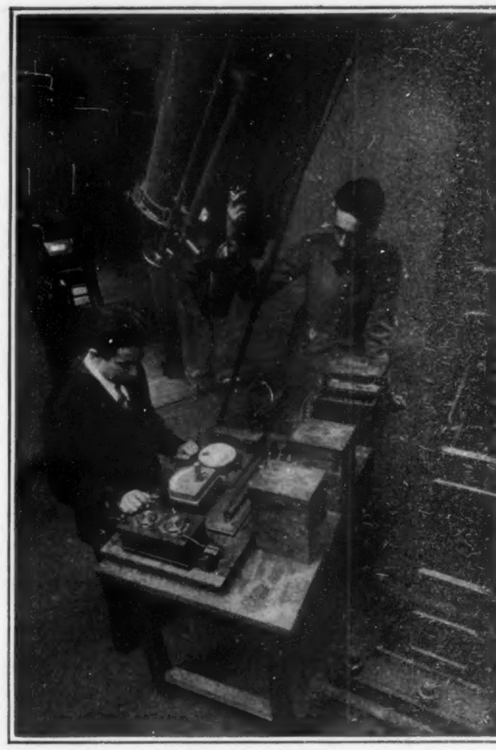
The photo-electric cell mounted for service, the box containing the two-grid tube (below) shown fitted on to the other part containing the cell

Such conversions and converters of energy are the basis of all modern civilization. The steam engine converts heat into mechanical motion; the dynamo converts motion into electricity; the glowing tungsten filament in an electric lamp converts electricity into light; the telephone converts sound into elecricity or electricity into sound.

Energy may be classified in six groups: heat, light, motion, electricity, sound, and chemical affinity. For a complete use of energy in the world we ought to be able to convert each of these kinds, at will, into any other kind. In proportion as mankind has solved these conversions civilization has advanced. Most of them have been solved, by now, with fair success.

But there is one that has not been solved satisfactorily, or at least it had not been solved up to the investigations that we are now considering. This is the conversion of light into electricity. We had converted electricity into light by the electric lamp; the reverse conversion had been made only with indifferent success.

There have been devised, of course, such instruments as the selenium cells used in the optophone of Dr. Fournier d'Albe and in the famous "electric dog," a curious scientific toy that will follow a light anywhere that it goes, twisting and turning as the path of the light does. But these devices have never been really useful. The proportion of the light converted by such selenium cells into electricity is very small and the operation of the instrument is undependable in other ways. It has already been attempted, for example, to apply these selenium cells to the measurement of starlight but without success. The selenium is neither sensitive enough nor accurate enough for use with such feeble light rays as these.



The soldier is opening the telescope shutter to expose the photo-electric cell, while the other operator watches the electrometer and milliameter readings

But the photo-electric cell of M. Jouaust and its accompanying radio apparatus does, at last, accomplish this conversion. What it may lead to only a bold man would dare predict.

Perhaps the largest store of energy available to man comes to him in the form of light. This is the energy of sunlight. If all the sunlight that falls on the land surface of the earth in a single day could be caught and saved for the use of man, it would equal the power obtainable from eighty billion tons of coal.

One day's sunlight would run all the factories, railway trains and steamships of the whole world for more than twenty thousand years. The trouble is that we cannot use this sunlight. We have not been able to convert it into other and more useful forms of energy.

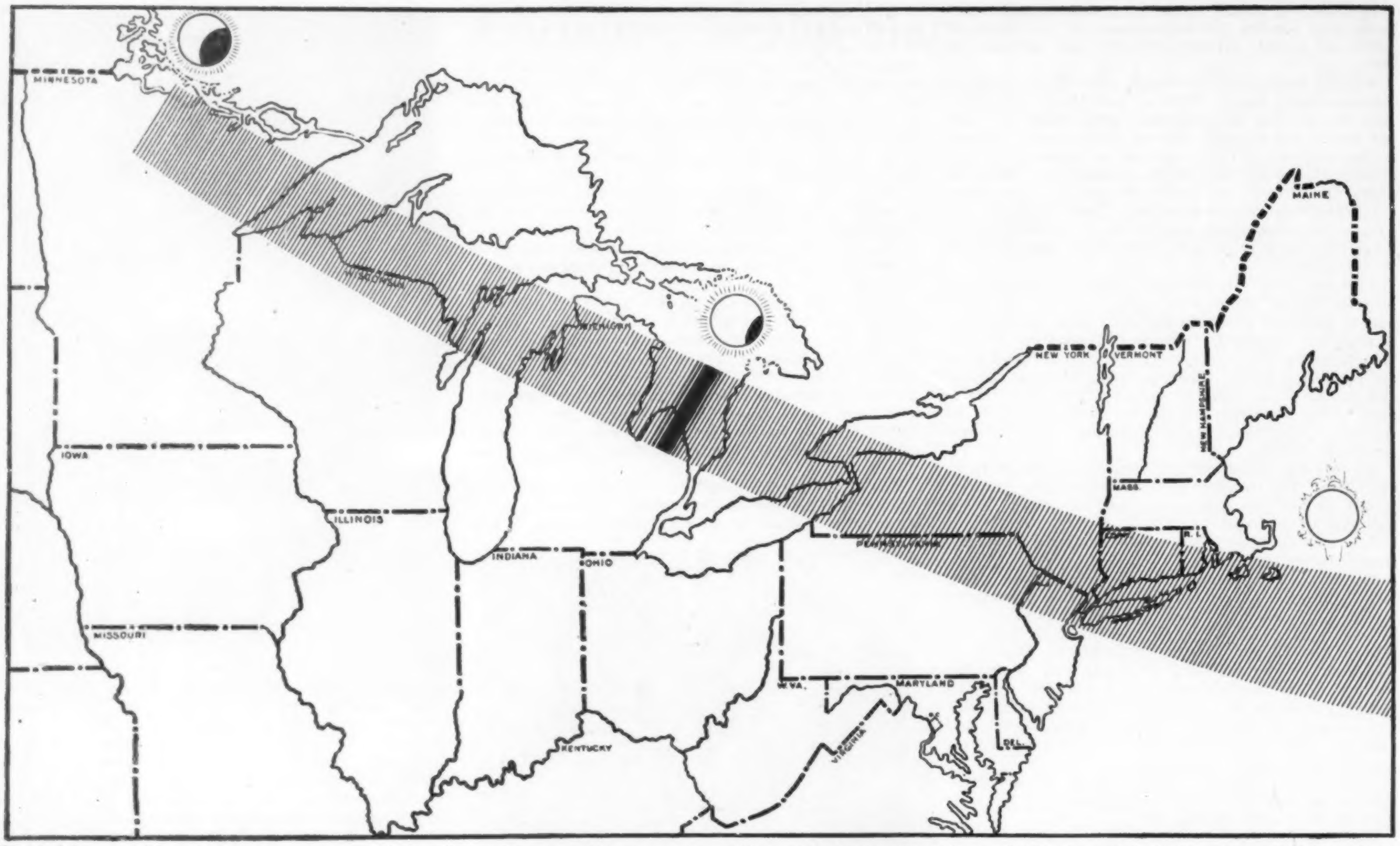
Are we to expect, then, to see the desert areas of the earth covered presently with vast photo-electric cells catching sunlight and converting its energy so that it can be distributed over the earth in the form of radio power? It is unlikely, although almost anything is possible.

But the world has gained, in these remarkable experiments of General Ferrié and M. Jouaust, the first step toward something of this sort. When Hero of Alexandria built his first steam propelled toy, it did not seem likely that he was about to make over the world. The first electric lamps that Mr. Edison began to play with were mere scientific toys. When Senatore Marconi first sent a few feeble dots and dashes through a few hundred yards of ether, no one foresaw the nightly operation of five hundred broadcasters in the United States alone.

The first steps of science are as feeble and uncertain as the first steps of a baby. But sciences, like babies, have a way of growing up.

General Ferrié and M. Jouaust have converted a light ray successfully into an electric signal, into a sound, into a mechanical motion in a clock. Hero and Edison and Marconi did not accomplish, at first, even so much as this.

Another recent invention of French radio science is the demountable vacuum tube of Dr. Holweck, a radio tube that comes apart for repairs. Mr. Delano, who is our special correspondent in Paris, will describe this remarkable tube in next month's issue.



The shaded area on this map marks the region in which the eclipse of the sun, next January, will be visible as a total eclipse. This is the so-called "shadow path." At the western end of this path the sun will rise already half eclipsed. At the location of the heavy line midway along the path the eclipse will be just at its beginning as the sun rises. East of this mid-point the sun will rise as usual and all the eclipse, from beginning to end, will be visible. The time of complete totality will vary from about two minutes for points near the central line of the shadow path, to a few seconds only for points near the north and south edges of this path

Help Us Study the Solar Eclipse

The Radio Listeners of America Are Invited to Assist the Scientific American's Study of Static, Fading, and Other Radio Effects During the Total Eclipse of the Sun Next January

ON January 24, 1925, the amateur scientists of America will have an unusual opportunity to render real service to science, especially to radio science.

On that day will occur a total eclipse of the sun, one of very few total eclipses that have been visible in the thickly-settled area of the Eastern States since the North American continent was occupied by the whites.

The path of the total shadow is shown on the map printed above. Buffalo, Ithaca, New Haven and many other cities are near its center. New York City is just at the southern edge of the strip of totality.

Professional astronomers at the great observatories are already making preparations for scientific work. The truth of the Einstein Theory, the mystery of the sun's corona, the remarkable "shadow bands" that sometimes accompany eclipses; all these and many other phenomena will be carefully observed by trained men provided with the best of instrumental equipment.

But there are some things that amateur observers, not equipped with expensive telescopes or spectroscopes, can do to help. In particular, there are important things that radio fans can do.

Last year in California there was another eclipse of the sun. The weather was cloudy and the astronomers got only very few photographs or observations.

But the few radio fans who had arranged to listen during the eclipse heard some remarkable things.

As the sun's shadow swept past at its speed of a thousand miles an hour, the intensity of radio signals suddenly increased, then suddenly decreased. The effects were somewhat the same as those of nightfall, but not quite the same. The observers on duty were too few to permit certainty.

So we are left with the question of what a solar eclipse really does do to radio transmission.

Does the shadow path behave like any other variety of darkness? Does it operate as a reflecting mirror to send back radio waves toward their point of origin, or does it bend them in one direction or another, or does it leave them unaffected? During the eclipse not only will the light from the sun be cut off, but also the stream of electrons that is supposed to be flying all the time toward the earth will be altered. What effects will this have on radio transmission?

No one knows the answers to these questions. The SCIENTIFIC AMERICAN proposes to try to answer them.

A group of qualified radio listeners and amateurs will be formed and instructed. Special signals will be sent out by selected broadcasting stations. The listeners will keep accurately timed records of signal strength, fading, static, and other features of radio reception. After the eclipse a committee of famous radio engineers will study this mass of information and will try to see what it means.

Do you want to have a part in this great test?

If you do, write to the Eclipse Editor, SCIENTIFIC AMERICAN, 233 Broadway, New York City, and say so. Be sure to give us *all* the information requested in the column to the left.

We will write you later and send you exact instructions concerning what signals to listen for, how to listen and just what records to make. You will receive, also, blanks on which these records can be sent in.

It is not necessary to have had any experience in order to help in this test. All you will have to do is to tune in early in the morning of January 24th, listen to the signals that we tell you to and report the results to us.

The eclipse begins at sunrise. It will be all over by about 10:30 A. M. The period of totality will last only about two minutes. Our observers will need about 30 minutes time, at an hour depending on their geographical locations. It will not be necessary to listen during the entire time while the shadow on the sun grows and wanes; only for a few minutes before, during and after the complete totality.

There will not be room for everybody on our groups of instructed observers. If you want to help, send in your application and the necessary information right now. Observers all over the United States are desired. It is possible that some of the most interesting data will be secured by listeners at a distance from the actual path of the eclipse.

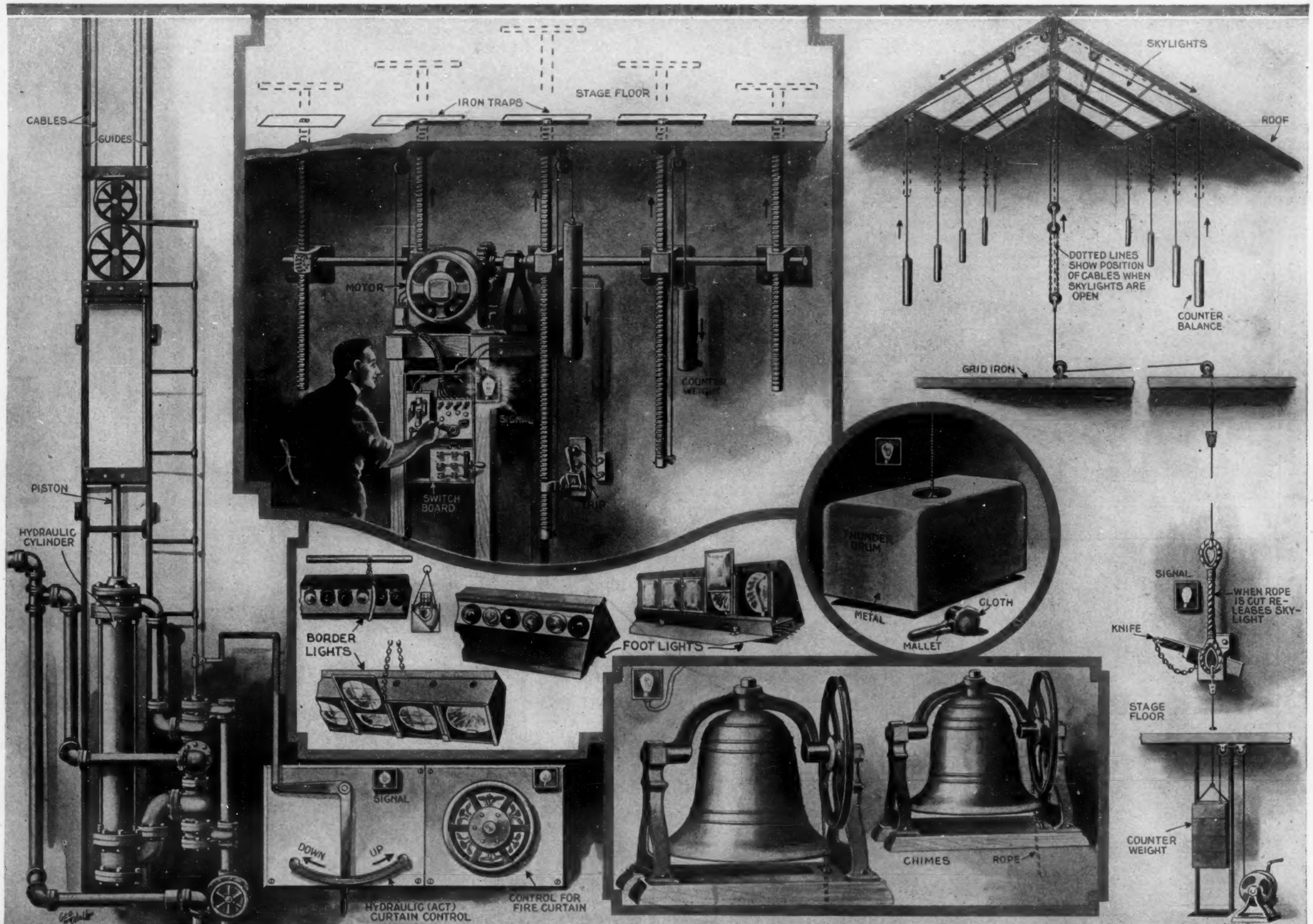
Applications will be acknowleged, but do not expect us to enter into extended correspondence about them. We will be too busy getting ready for the eclipse itself.

Radio Fans Attention

Help us find out what the eclipse of the sun will do to radio. If you are willing to help, send the following information at once to our Eclipse Editor. Be sure to answer ALL the questions.

1. *Your name and mail address.*
2. *What is the make and design of your radio receiver?*
3. *What kind and size of antenna do you use?*
4. *Do you use storage batteries or dry cells?*
5. *Are you located in open country or in town?*
6. *How long have you been a radio fan?*
7. *If you have an amateur license will you be willing to send signals if we ask you to, instead of listening?*

Address:
The Eclipse Editor,
SCIENTIFIC AMERICAN,
233 Broadway, New York, N. Y.



Our cover illustration takes the reader into the little-known part of the theater behind the scenes, showing the board, just to the side of the proscenium arch, from which the cues are given. Here the stage manager pushes buttons, turns switches, and sends calls over telephones. The drawing on this page goes more into details. To the left we show the hydraulic installation at the Century Theater, New York, for raising and lowering the curtain. In the event of fire, the asbestos curtain can be lowered by hand, independently of this mechanism. At the extreme right the artist shows another safety device—a rope, at the back, which is cut in case of fire, releasing the skylights as shown and allowing the flames to go upward rather than outward toward the audience. The manipulation of the five iron traps in the stage floor is shown in the middle of the drawing, above. The cue is given by a light, the stage hand turns the rheostat, and up go the traps. If they go too high a counterweight trips the switch. Below this drawing are shown border and foot lights of the latest type. The colors are changed at will by changing the lamps or the screens in front of them. The oblong and circular inserts show some of the apparatus, up in the flies, for producing such effects as thunder and chimes. For courtesies in preparation of this drawing we are indebted to Mr. Eugene Braun.

BEHIND THE CURTAIN OF A GREAT THEATER—SOME OF THE THINGS THE AUDIENCE NEVER SEES

Our Post-War Navy

Maintaining the Fleet on the Treaty Basis

By Commander H. C. Dinger, U. S. N.

THE Disarmament Agreement defines and restricts, to a considerable extent, our building policy, which, as now carried on, may be defined as the proper maintenance of the Treaty Navy. Battleships and aircraft carriers are limited, but aircraft, cruisers, submarines and auxiliary vessels are not limited. These latter need be limited only by the appropriations made by Congress. It is necessary to recognize that these appropriations should be used wisely in securing the vessels that are of greatest relative value for carrying out the current political policies of the country. Money should be spent only on such new vessels as are vitally necessary and for which demonstrated need exists. Furthermore, decision must be made as to how much priority is to be assigned new construction as against expenditures for maintaining our present vessels in proper operating condition. As it is unprofitable to maintain obsolete equipment in repair the process of eliminating non-essential material and personnel must also be an active one. Much has been junked in the past few years but in the interest of economy and naval efficiency there is still much more that should be junked.

The war has served to teach numerous lessons, many of which have not been fully learned and many which may never be acted upon.

Some of the principal lessons appear to be:

(a) The great dependence that must be placed upon the merchant marine for both material and personnel.

(b) The direct reliance upon the industry of the country to produce material and mechanisms that are not developed till war is at hand.

(c) The great tendency in these industrial times to improvise weapons as occasions and conditions demand and the rapid obsolescence of weapons during the conflict.

(d) The great effect of new developments in aircraft, submarines, mines, radio communication and listening devices.

(e) The great need for better cooperation and mutual understanding between the military, naval and industrial forces of the country. Such cooperation will result in greater efficiency and a considerable economy in expenditures.

(f) The necessity for mobilizing the scientific talent of the country to assist in solving the various problems that may present themselves to the naval and military authorities.

(g) The necessity of having definite practical plans and well-defined skeleton organization for quick expansion into war-time activities. The importance of this was very forcibly brought to the attention of the country during the exercises and mobilizations of Defense Day and by the literature which preceded it.

Capital Vessels

In spite of possible future developments in the air and under the surface of the water, the major operations in a naval war will center around the two fighting fleets; the essential part of which is made up of capital ships. These will be, as they have been in the past, vessels heavily armed and protected and built *primarily* to oppose the *capital vessels* of the enemy. Such vessels are a developed compromise between armament, protection, speed, endurance, and sea keeping qualities. Each of these essential qualities must be developed to its possible limit without unduly detracting from the others. The latest designed United States battleships are such a developed compromise. They are vessels carrying the heaviest armament and greatest protection combined with great cruising radius and fair speed.

WE commend this article to the careful perusal of every voting citizen who takes an intelligent interest in the United States Navy. Before the war the SCIENTIFIC AMERICAN *urged that our Navy, to be truly adequate and representative, should be increased and strengthened until it stood second in strength among the world's navies. Today, thanks to the Washington Treaty, it is first in strength, sharing that position with Great Britain. There has been too much anti-treaty propaganda, chiefly the work of a very small minority of our naval officers. Fortunately this has failed of its purpose. The country and its Congress, who are well satisfied with the Treaty, demand, however, that our Navy shall be maintained at full Treaty strength. How this may best be done is clearly laid down in this article by Commander H. C. Dinger.*—THE EDITOR.

The most likely improvement in battleship design:

(1) In providing better offence against and protection from aircraft.

(2) In increasing range of artillery.

(3) Improvement in fire control.

(4) Protection against gas.

(5) Improvements in machinery to enable the cruising radius to be increased. Certain recent engineering developments indicate that the cruising radius of existing capital vessels can be doubled by fitting certain special machinery for use at low cruising speeds.

Scouts or Light Cruisers

The late scout cruisers are vessels of highest speed, large radius and should have good sea-keeping qualities. The present United States cruisers are also fitted as mine layers. The disarmament treaty does not limit the number of these vessels that can be constructed. The present design can be improved upon by reducing the number and increasing the caliber of the guns. Six 7-inch guns in three twin mounts on centerline would be better than the present armament of 12 six-inch guns as mounted. The cruising radius can be materially increased by utilizing special cruising arrangements in conjunction with the turbo reduction gears. With this modification of armament a larger number of airplanes can be carried.

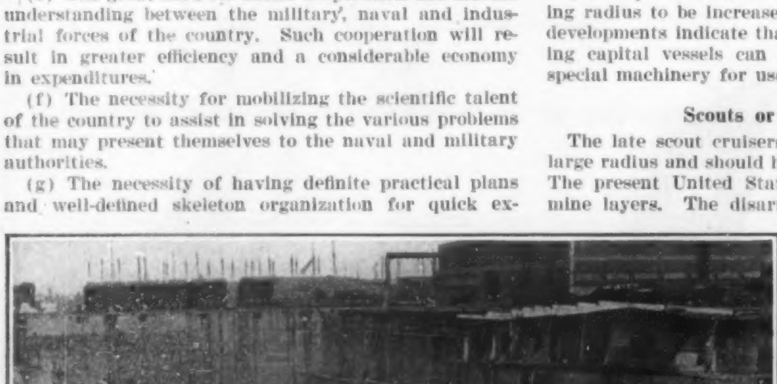
To accomplish the above, the size of vessel need not be increased in displacement over about 8000 tons. On the basis of results per money expended it is not deemed advisable to unduly increase the size of these vessels. If they are kept within reasonable limits a larger number can be built for the same money. They will cost about $8,000,000 apiece. The Navy is not restricted as to this type and therefore a limited number of these vessels may be put under construction within the next few years.

The development of the heavy bombing plane makes the operation of the scout cruiser within 500 miles of a bombing air station rather risky. However, there is still a large part of the ocean outside of this radius.

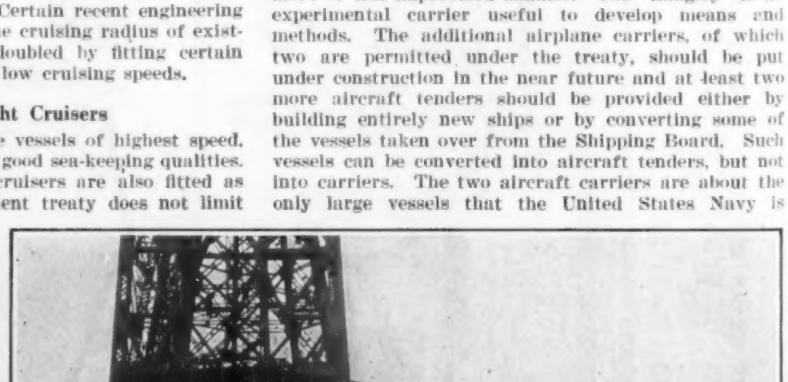
These cruisers, in conjunction with a number of destroyers and submarines will make a very formidable scouting unit, capable of searching out enemy advance bases, and attacking troop transports or convoys of merchant ships when a strong escort is not present. Another role will be the apprehension of similar enemy vessels engaged in raiding or commerce destroying.

Aircraft Tenders and Carriers

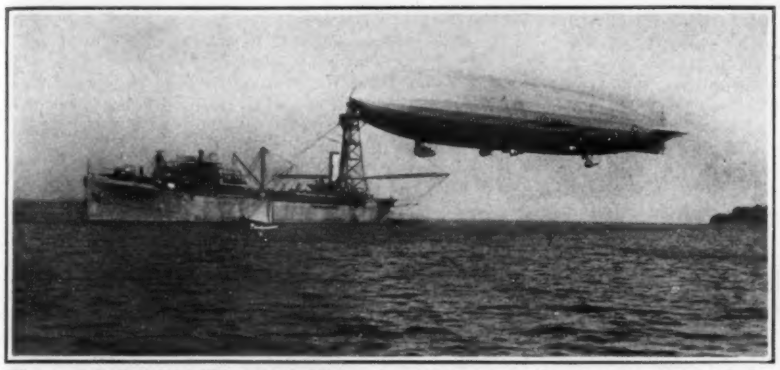
In order that the Navy may take full advantage of aircraft development, both aircraft tenders and airplane carriers should be provided for. Two of the battle cruisers are now being converted into airplane carriers (their completion may be expected in about two years). These two should prove very serviceable for this purpose. The U. S. S. "Wright" and "Aroostook" are equipped as tenders for aircraft, but in a more or less improvised manner. The "Langley" is an experimental carrier useful to develop means and methods. The additional airplane carriers, of which two are permitted under the treaty, should be put under construction in the near future and at least two more aircraft tenders should be provided either by building entirely new ships or by converting some of the vessels taken over from the Shipping Board. Such vessels can be converted into aircraft tenders, but not into carriers. The two aircraft carriers are about the only large vessels that the United States Navy is



Double bottom and bulkhead plating of the "Minnesota," which was broken up in accordance with the Washington Treaty



An upper section (two decks) of the "Minnesota" cut through by the torch and lifted bodily to an adjoining dock



The naval dirigible "Shenandoah" as she appeared at the mooring mast of the U. S. S. "Patoka," which has been converted to act as a seagoing tender for the airship. The mast, which extends about 175 feet above the water, is provided with piping through which oil, fuel, water, etc., can be supplied to the ship

permitted to lay down for some years. Their construction would serve to keep some of our shipyards in hand on naval building work.

Destroyers and Submarines

The type developed during the war is a very satisfactory one and the United States has a large number of these. Considerable sums will have to be spent to maintain them in condition. Only about one-third of the total number are in active service.

The United States has a very respectable aggregation of submarines and the boats of the "O," "R" and "S" classes may be considered very satisfactory types. A considerable number of the "S" Class are still in the builders' hands.

Three of the large fleet type submarines are also building. These are large and very costly vessels and the success of these large high-speed submarines is a matter of debate. The mine layer type of submarine is now absent from the Navy program and it would appear proper that in the next submarines to be laid down the mine layer type be included.

If we are to have a Navy at all worth while, the personnel and material must be kept up, within such limits of expenditures as Congress may set. The building of new vessels and the making of new devices must be continued, else progress will cease. The dead wood both in material afloat and stations ashore should be eliminated. The pruning knife may yet be applied with good effect to numerous stations that make heavy inroads on naval funds and give very little in return. Money thus saved should be put into useful experimental and development work.

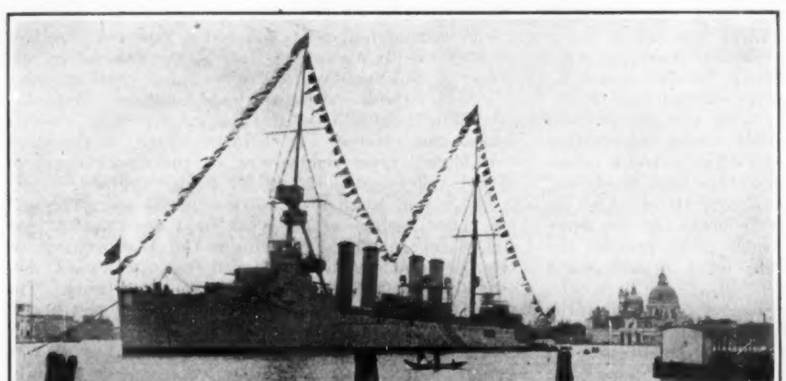
The United States Navy possesses the most numerous and powerful destroyer fleet afloat, with 307 boats to the British 195. Two-thirds of this force are laid up, as shown in this photograph taken at the League Island Navy Yard, Philadelphia. The boats are most carefully maintained by a force which has them in charge. The machinery is regularly guarded and the hulls painted.

Tenders and Bases for Submarines and Aircraft

The use of aircraft and submarines in offensive action away from the home coast requires new developments in the way of tenders and bases. Tenders are merely movable bases. Our outlying naval bases should of necessity be provided with aircraft and submarine facilities for their defense as well as for carrying on offensive operations. The late war clearly indicated that major naval operations will be carried on from bases and that naval bases properly maintained enable the naval forces to control the sea. In any future war aircraft and submarines with listening devices will play a very important role. These new agencies, together with special radio development, have revolutionized the matter of scouting and communications, as well as the handling of escorts and convoys. Development of anti-submarine and anti-aircraft equipment is most important and our naval bases should be well outfitted with facilities for radio communication and listening devices. The very much reduced appropriations of the past two years and the expense of maintaining too large a number of vessels in active service for the personnel available has operated to prevent little or no expenditure upon the necessary equipment of important bases. As less funds are required for construction of new vessels and for maintaining unnecessary or nonessential vessels in operation, more money should be available for providing the essential equipment of important bases. The important outlying bases should be first equipped, since these will be in the possible area of hostilities. Navy yards are needed for the production and repair of naval material but are rather unlikely to be the bases from which the fleet will operate in any contingency to be expected, at least in the next twenty years.

Experimental Work

The most important naval activity in time of peace is experimental and research work for the purpose of developing all manner of possible weapons, devices and equipment which may be of use in overcoming the enemy. This work is always in danger of being neglected in times of peace, yet it is that which gives the largest returns for the money spent upon it. It, therefore, behooves those desiring results from our naval expenditures to see that experimental and research work are allowed to continue in reasonable volume. The establishment of the naval Research Laboratory at Bellvue, near Washington, should give valuable returns. Our navy yards also can be profitably used for experimental and research work to a much greater extent than they have been in the past. The results of such continuous experimental activity is of benefit to the general industry of the country as well as to the Navy. Experimental work also should be encouraged among the private manufacturers of naval material.



American scout cruiser "Detroit" at Venice, dressed with flags in honor of Armistice Day. Though our Navy is short of light, fast cruisers, we have ten, like the above, that are among the fastest and most powerfully armed in the world. In the distance is Salute Church, which is a familiar feature in many of Turner's pictures. These vessels are 550 feet long, and of 9000 tons displacement. They mount twelve six-inch guns and make 34 knots

Personnel

The enlisted personnel may be increased or decreased 10 or 15 per cent without materially altering naval efficiency. When a larger force is allowed, more trained men are produced while the appropriations have to be larger to pay for this. The war capacity of the Navy is not dependent upon the peace complement of the Navy at any time, but rather upon the number of men who have graduated through naval training and can be made available for service on short notice. The maximum number of men trained for useful service should be the peace-time aim of the navy rather than the continuous service of a maximum number of men. The navy in peace time should be a training school for personnel that can be available for expansion in case of war. A sufficient permanent force must be provided in order to man the vessels in service and carry on the training. Eighty-five thousand is not too big an allowance. In fact it is the minimum with which any semblance of maintaining the Treaty Navy can be attempted.

Let us train the maximum number of men that the current appropriations will permit. The number actually in service is not a measure of our naval capacity, but it is a measure of our capacity to train. It is, however, very essential to keep up an effective *Naval Reserve*, particularly the Fleet Reserve, and to improve its efficiency. It is from this source that the naval personnel will be augmented in time of hostilities. The permanent force is merely a nucleus of the war-time force. This fundamental fact must not be lost sight of, either by the Navy or by the public.

The great essential thing in keeping up and improving the Naval Reserve is to see that the organization of the naval districts under the district commandants is properly maintained and administered so as to keep a numerous and effective force of naval reserves available for service on short notice.

The coming years must necessarily be a period of retrenchment in government expenditures. The Navy must do its share in helping out this economy or else expect an arbitrary cut by Congress. If the Navy is granted authority to have an enlisted personnel of at least 85,000 and the present allowance of officers, the Treaty Navy can be maintained within the present appropriations. The Navy, however, must not only be willing but zealous to cut out all possible sources of waste. The Navy is, as yet, not down to bed rock in this matter. Unnecessary stations should *not* be kept in operation and those kept in operation should be *most economically* administered. The whole personnel allowed must be usefully employed the whole 12 months. A number of nondescript vessels that are not essential for training of personnel, such as non-essential district

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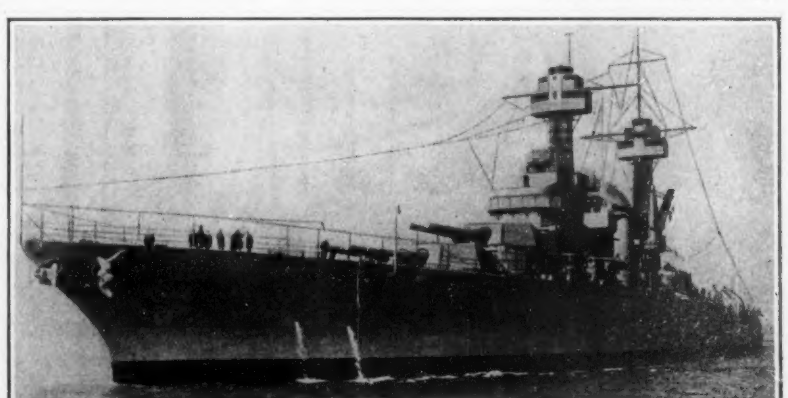
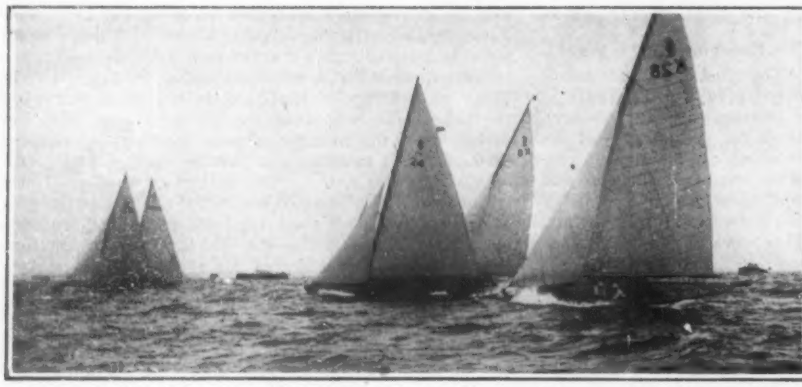
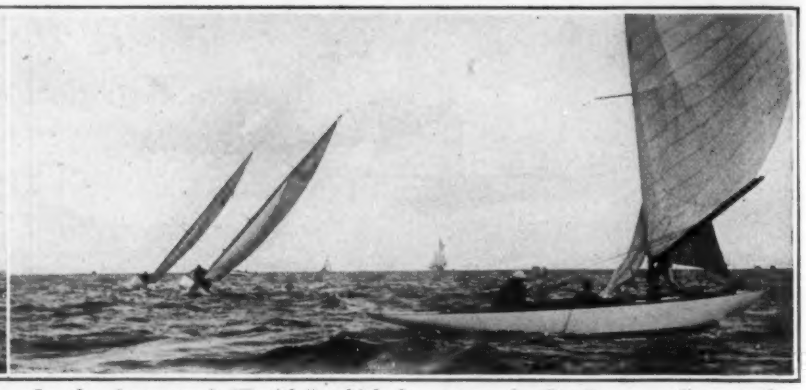


The U. S. battleship "Virginia," one of five 32,000-ton, sister ships, which are the largest and most powerful afloat. She mounts eight 16-inch, 50-caliber guns and carries 1400 officers and men



Start of the first race. "Betty" (K-28) the winner; "Paumonok" (24) second; "Zenith" (K-8) third at the finish



In the foreground "Zenith," which has squared off after rounding mark. "Thistle" and "Heron" approaching mark

Six-Meter Team Race

Third Series of Contests for the International Cup

IT was a happy thought that prompted the offer of a cup to be raced for by small boats of British and American design and construction; for, thanks to the war, the cost of the sport has risen to such a high figure, that it has become prohibitive in the larger classes of yachts, except to the man with a very deep purse.

The six-meter craft, which will average about 21 feet on the waterline and 34 feet on deck, with about 500 square feet of sail, can be built in England for about $6000 and cost about $7500 in America, and, since they are sailed mainly by Corinthian crews, a yachtsman does not have to be a Croesus to indulge in the sport.

The six-meter boats are designed under the International rule of measurement, which aims to discourage the shallow, scow-like form of hull, with its deep fin keel and exaggerated overhangs, which was developed by the waterline-length and sail-area rule, under which so many of the America Cup contests formerly were held. The International rule seeks to promote a healthy type of boat, free from all exaggerations and freakiness, and with moderate draft, beam and sail area—a type that can be used, if the owner wishes, for cruising or ordinary summer sailing, by adding a trunk cabin. The rule is so drawn as to encourage high freeboard, a deep body and moderate overhangs, all of which go to make a wholesome, serviceable boat. At the same time the limitations are not such as to prevent the turning out of a fast boat on any point of sailing and in any kind of racing weather.

It was inevitable that the designers of each country should have in mind the prevailing local weather and sea conditions and shape their craft accordingly. On Long Island Sound the prevailing summer winds are light and the seas smooth. In the English Channel the winds are fresh, the tides strong and the seas are usually choppy. Light winds mean low speed, and at low speed the chief resistance is the skin friction; for at low speed the wave-making is almost negligible. Hence it is desirable to keep down the area of wetted surface. This can be done by giving the boat a deep, general V-section body, with short overhangs. Such a boat is Gielow's "Lea," which seems to be almost unbeatable in light airs. "Lea" has been chosen for the third time as a member of the American team.

In strong breezes, as the speed increases, wave-making sets in. To keep this down, the British design their boats with a shoaler body, harder bilges and longer overhangs, aiming to secure longer and easier sailing lines at the expense of a larger wetted surface. The results of the races are what might be expected; for in past years the American boats have won on the Sound and the British in the Channel. Thus far, three series of contests have been held. The first, sailed in 1921 off Cowes in fresh breezes, was won by the British; the second, sailed in 1922 on Long Island Sound went to America; and last year the British were successful in their home waters. The cup becomes the property of the country which wins it three times. Hence the special interest aroused by the 1924 contest. A win for Great Britain would give her the cup.

The team of four boats selected to represent America includes the light-weather "Lea"; "Paumonok," an improved "Lea," modified to give her more speed in heavy weather; (both of these are Gielow designs); "Dauphin," by William Gardner, a fine light-weather craft; and "Heron," by Clinton Crane, a powerful, hard-bilged, type, reminiscent of the knockabouts of earlier years and designed for heavy weather.

Of the four English boats, two, "Betty and "Thistle," are sister designs of last year by Fife; "Zenith," designed for this race by Fife as an improvement on "Betty," and "Echo," designed by Glen-Coats, her owner, an amateur who designs his own boats. The three Fife boats are 25 feet on deck by 7 feet beam; the "Echo" is 25 feet by only 6 feet 3 inches beam. "Zenith" is the best boat on her record, having won 14 firsts this year in British waters to 9 firsts by "Betty." "Echo" came out late in the season and is a comparatively untried boat.

The races were sailed off Oyster Bay. The first, over a windward and leeward course, was favored with a good breeze of 12 knots, with puffs of 16 knots. "Betty" and "Paumonok" stood inshore out of the tide and sea and pulled out a lead which put them well ahead, "Betty," first around the mark, leading "Paumonok" by over a minute and a half, with "Zenith" nearly two minutes astern of "Paumonok." The British won with 19¼ points to 17 for the Americans. Though the American team was beaten, it performed unexpectedly well in the strong wind and sea.

The second race, sailed in an 8-knot breeze and smoother sea over a triangular course, was won by America, with 19 points to 16¼. The result was a foregone conclusion when "Echo," on the port tack, touched "Paumonok," which was on the starboard tack. "Echo" finished the first round in third place; but after the foul (her own fault), she withdrew. "Dauphin" sailed a fine neck-and-neck race with "Zenith," until the British boat pulled away on the last leg, a reach, winning by 33 seconds. "Betty," third in the race, crossed 39 seconds later, followed by "Paumonok," "Lea," "Heron" and "Thistle."

British-American Cup Races, 1924

	1	2	3	4	5	6	7	*Total Points*
B. "Zenith"	6	8¼	6	6	8¼	7	8¼	49¾
B. "Betty"	8¼	6	2	8¼	5	4	5	38½
A. "Lea"	3	4	3	4	6	5	7	32
A. "Paumonok"	7	5	5	1	3	6	3	30
A. "Heron"	5	3	7	7	4	3	1	30
A. "Dauphin"	2	7	4	5	7	F	4	29
B. "Thistle"	1	2	D	2	2	8¼	6	21½
B. "Echo"	4	F	8¼	3	1	2	2	20¼

A. American. B. British. F. Foul. D. Dismasted.
Great Britain: Races won 4. Total points 129¾.
America: Races won 3. Total points 121.

The third race sailed in a squally 20 to 25-knot wind, with rainstorms and a rough sea, was a decided triumph for the American boats, since all four came through intact while three of the British craft were more or less disabled. "Betty's" mast snapped off ten feet above the deck when she was in fifth position, and she finished last under jury rig, using her boom as a mast. "Thistle's" mast went at the deck when she was in fourth place and she was towed in. "Zenith's" boom broke on the first windward leg. It was repaired and she came in third. There was no mishap to the American boats and although for the third time a Britisher (this time "Echo") led the fleet home, the race went to America, with 19 points to 16¼.

"Thistle," one of the three Fife boats. Note the shoal body and long overhangs. Ahead is "Echo"

"Dauphin," a Gardner boat; fast in light airs, which was second, however, in the heavy blow that dismasted two boats

The British won the fourth race, with 19¼ points to 17. "Betty" held the lead throughout the race. She was closely followed by "Heron," which sailed well in the breeze of 10 to 12 knots, and was 1 min. 11 sec. behind her at the finish, with "Zenith" 15 seconds astern of "Heron."

The fifth race, sailed in a typical, light, southwesterly breeze saw the most thrilling duel of the contests, between "Zenith and "Dauphin." At the last stakeboat before the finish, "Dauphin" was 24 seconds ahead of "Zenith," and in the run down the wind, "Zenith's" strong point of sailing, she drew up level, passing "Dauphin" at the line and winning by only one second, or a few feet. Score in points, America 20, Great Britain 16¼.

Light winds characterized the sixth race, in which "Dauphin" won by 21 seconds over "Thistle" and 48 seconds over "Zenith." Like "Echo" in the second race, she fouled, while on the port tack, a competitor on the starboard tack and was disqualified. Score: British 21¼, American 14.

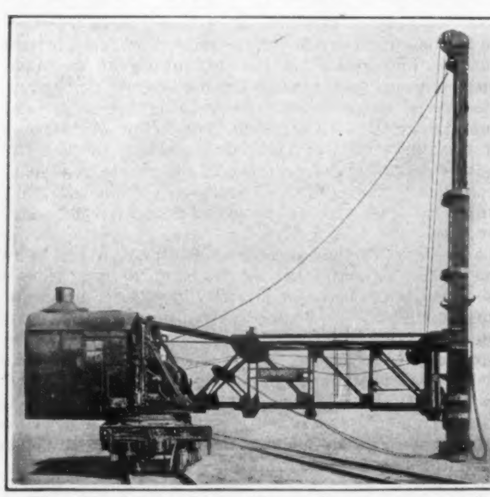
The seventh and decisive race (the score standing 3 all) was won by the British with a score of 21¼ to 15 points. "Zenith," which led from start to finish, sailed surprisingly well in the light breeze, finishing first, 1 min. 22 sec. ahead of "Lea," herself a remarkable light-weather boat.

The final score in races was four to three. How closely the teams were matched is shown, however, by the score in points of 129¾ to 121. Although the cup becomes the permanent possession of the visitors, it is probable that another cup will be offered and the spirited racing in these fine boats perpetuated.

Precious Stones in Plants

ONE of the last places in the world in which one would expect to find precious stones would be in the stems of plants. Yet, now and again, substances which closely resemble opals and pearls are discovered in certain plants. The giant tropical bamboos grow in large clumps to the height of one hundred feet. In the young stages of growth the hollow stems of the bamboos are filled with a jelly-like substance. As time goes on this dries up and an interesting mineral deposit known as tabasheer is formed. Some of this plays a part in making the bamboo stems stiff and strong but, now and again, there is an excess of the mineral which settles in more or less rounded lumps at the joints of the stem. These are pale blue or white in color and, on being heated, become brightly phosphorescent. There is a close chemical connection between the lumps of tabasheer in the bamboo and an opal and the general color and the manner of light reflection are much the same.

Stones are, now and again, met with when sawing up trunks of teak, rosewood, and certain other trees. These masses are embedded towards the center of the stem and it has sometimes been thought that they got into their position when the tree was young and, as time went on, have become enclosed by the growing wood. Of course such things do happen in the life of trees for not only stones but pieces of iron and other metals have been found. The stones under consideration, however, are produced by the tree itself and are closely similar in their formation to pearls. These vegetable pearls are almost entirely carbonate of lime



The pile driver that will go where a man can't

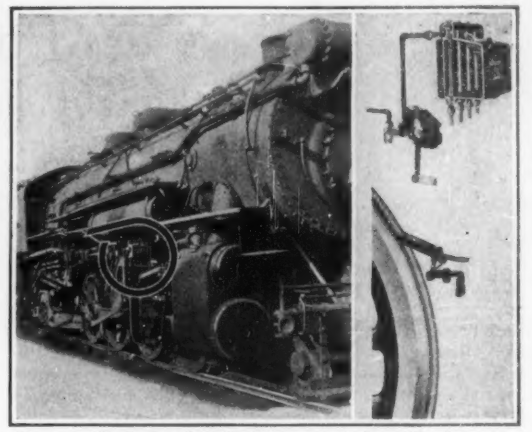
Lubricating the Flanges of Locomotive Wheels

A GREAT many things we do become so very commonplace that it never occurs to us to question them. One of these customs which has run along many decades "on momentum," so to speak, is the omission of lubrication of the flanges of railway rolling stock. Here is a place where there is often a great deal of friction—especially in recent years, when rolling stock is very heavy. Flanges, especially those of heavy locomotives, wear thin and break, causing derailments. Taking in consideration a long train, there are hundreds of wheels with flanges all trying part of the time to ride up or climb the rail because of the cars being thrown to one side or the other. When a curve is hit the tendency to ride up and over is, of course, very great and if the speed of the locomotive is kept above the critical point this will happen.

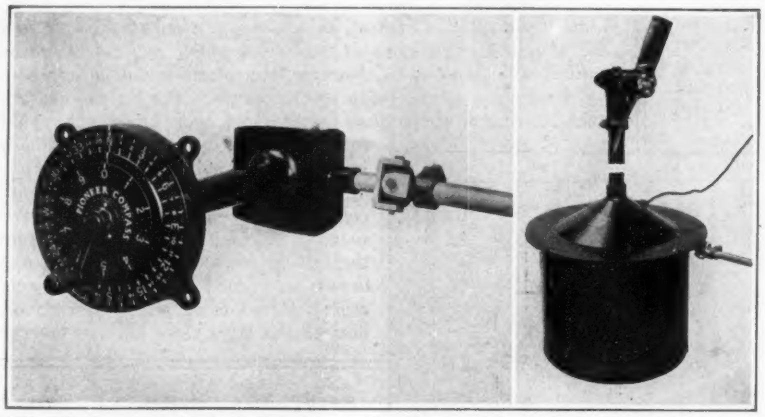
A Chicago, Illinois, manufacturer has worked out a method of keeping the flanges lubricated without much attention from the train crew. This oiler works while the train is in motion and stops when it stops.

Oil is fed by air pressure working through tubes which connect up with special oil shoes making contact with the flanges. This air pressure is controlled by a valve connected to the radius bar or valve stem of the locomotive. This valve admits air pressure to the lubricator for a moment at each hundred revolutions of the driving wheels. This pushes the discharge pistons down into the cylinders in the lubricator, feeding a measured amount of oil to the shoe on the flange.

In cold weather warm air is used to force the oil out through the pipes, so that it will not become too viscous for easy application to the flanges.



Pneumatic flange lubricator, mounted on the locomotive and (right) shown in detail



When the brushes in the vertical armature within the pot of the fieldless generator (right) are set for the chart course (see dial, left) to be flown, none of the earth's lines of magnetic flux will be cut and a zero reading will show on the meter as long as the plane follows that course

Essential parts of the earth-inductor compass for airplanes

A Versatile Pile Driver

A PILE driver for railroad use has recently been developed by a Cleveland, Ohio, manufacturer, which is about the most flexible, adaptable sort of an implement imaginable. The pile-driving gear is carried on the outer end of a long truss in such a way that piles may be driven anywhere within a radius of 32 feet. Exact spotting may be done by changing the position of the truck which carries the whole machine on the track. The weight of the boiler on the one end of the truss counterbalances the weight of the pile driver on the other end.

Sometimes piles have to be driven with a batter, instead of straight, or plumb. To provide for this a battering arrangement which affords nine positions is built into the rig. On first looking at an apparently clumsy rig of this sort one might be pardoned for asking how it could be moved about on any railroad, owing to bridges and other obstructions. In our illustration, note that there is a pivot at the upper right-hand corner of the truss which carries the pile driver. This permits the whole pile driver to be lowered on the top of the truss and when this has been swung back over the truck, which has to be quite long in order to afford space to carry it, the whole rig is folded up as neatly as a closed umbrella. Incidentally, the long truck has the advantage that it distributes the weight of the outfit over a larger area of track than would be the case if it were as short as the average railroad crane. Machinery of this sort is usually loaded with heavy bulks of cast iron, so that it is necessary to consider track loads.

This pile driver can be changed into a fast operating, heavy duty locomotive crane very easily and in a minimum of time, it having been designed with such an eventuality in view.

The Earth Inductor Compass

AVIATORS have never been able to make satisfactory use of the common mariner's compass. For one thing, the compass card is altogether too subject to vibrations. It is not "dead beat." Yet flying above the clouds is sometimes desirable and will probably become more and more so with advancement of aviation as a method of travel when we begin to take advantage of the extremely high wind velocities at high altitudes above all clouds. Long journeys across unexplored areas, where there are few or no landmarks such as the lights of cities at night, will also make this sort of flight a problem.

A Brooklyn manufacturer has just pioneered a brand new method of finding oneself in places like this, or rather of keeping oneself found. The earth inductor compass, invented by Mr. M. M. Titterington, makes use of the same magnetic field of the earth which directs the common mariner's compass, except that it makes use of it in a new way.

If one were to take a generator of the vertical shaft type and remove the field coils altogether, and then cause the armature to be revolved, a current would be generated. This current would be weak, of course, but it would flow because the very weak lines of flux of the earth would have been cut by some of the coil, unless the brushes were placed in such a manner that each coil when momentarily in contact with them was parallel with the lines of flux of the earth.

This is just what takes place in the earth inductor compass. First there is the generator, which is similar to any common generator. It has a vertical shaft which extends high enough to take a small impeller fan, bevel geared to its end. This keeps the armature revolving as the plane flies, although this end may be effected by any other means desired. However, if the brushes are so placed on the commutator at any given moment of flight that lines of force are cut by the armature coils temporarily in contact with the brushes, a current will be generated. That current will cause a reading to appear on the meter, which is simply a common voltmeter.

The corollary of this is that if one steers the plane in such a manner that the coil in question is kept parallel to the lines of force, no reading will be observed. Then all that remains to do is to provide an easy way to set the brushes at the point desired. This is done by means of a handle working on a dial. Since the generator is mounted on the rear of the fuselage where local magnetic influences due to the engine are minimized, this connection is made by means of a long shaft, with suitable toggle joints wherever a direct line is impracticable.

In practice, if the course required by chart reckoning were, let us say, South 30 degrees West, the little handle is set on the dial at that point (see illustration). Then all that is required of the aviator is to keep his eye on the hand of the meter and see that it does not get away from zero reading, or bring it back when it does.

The planes which have been engaged in flying 'round the world are equipped with these earth inductor compasses, and they have proved highly valuable in that record flight. A number of planes in both the Army and the Navy are already equipped with the new compass.

Putting Heat in the Bank

Thermal Critical Points, and Their Relation to the Heat Treatment of Steel

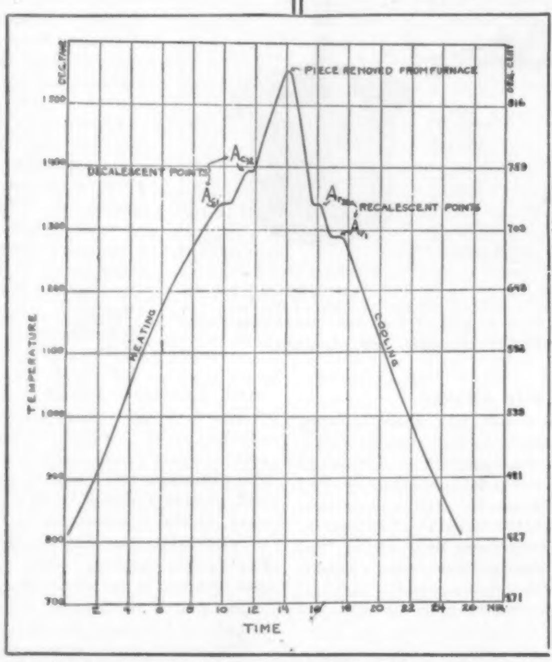
By Arthur L. Collins

MOST of us know that, after a material has been heated to its melting or its boiling point, additional heat must be supplied to bring about the change from the solid to the liquid or from the liquid to the gas; and that while this change of state is thus being effected no rise in temperature occurs. The mere passage from the one condition to the other involves the doing of certain work, which in turn means the absorption of an amount of heat that is surprisingly large. For instance, in converting ice to steam, slightly more than seven times as much heat is consumed in bringing about the actual melting and vaporization as in heating the water through the temperature interval between melting and boiling points. And, of course, in carrying the process backward, condensation and freezing liberate the same amount of heat that is absorbed in evaporation and melting.

Most of us, however, do *not* know that in addition to the melting and boiling points, many substances possess other "thermal critical points," at which increase of temperature is temporarily suspended while any heat supplied goes to work to effect a change of some sort in the condition of the material. The entire practice of heat treatment of steel is based upon these critical points and the changes which they bring with them.

Suppose that a recording thermocouple be placed with a piece of, say, 0.60 per cent straight-carbon steel in an electric furnace, in such a way as to record the temperature of the steel itself. The temperature will be seen to increase at a rate approximately uniform up to a critical point between 1350 and 1400 degrees (Fahrenheit, as throughout). Here it remains momentarily fixed; but soon actual heating is resumed, until a second critical point is attained between 1400 and 1450 degrees, where retardation is again noted. Then follows the normal increase of temperature without further interruption.

If we now remove the steel from the furnace and allow it to cool naturally, this will continue down to a point between 1350 and 1300 degrees, where for a brief period heat is evolved without actual cooling — indeed, the temperature will actually rise momentarily. On resumption of actual cooling a second hiatus will occur at a temperature between 1250 and 1200 degrees; below this cooling is uninterrupted. The heat absorbed by some transformation, as yet undefined, during heating, is given off again when the transformation is reversed during cooling. But unlike the melting-freezing and the vaporization-condensation points, the critical temperatures going up and coming down are not identical. Had this experiment been charted with intervals of time as absissae and temperature in degrees as ordinates, something like the above graph would have been obtained.



Graph showing the behavior of steel under heating and cooling, with respect to thermal critical points

The critical points met in heating are known as points of decalescence (denoted as Ac points) those of cooling as points of recalescence (denoted as Ar points). The latter lag behind the former because the metal offers a resistance to change, which raises the decalescence point and lowers the other. The more slowly heating and cooling take place, the less is this resistance, and the less the displacement of the corresponding critical temperatures from a point, theoretically to be met in infinitely slow heating and cooling, where they would be identical. Conversely, the spread between decalescence and recalescence may be widened by very rapid heating and cooling. Indeed, by severe quenching the recalescence point may be so lowered that the metal has time to become rigid before the transformation can occur, thus preventing it from taking place at all.

Again, there is a "lowering temperature," higher than the topmost critical point. If cooling is begun at various temperatures *below* this, no variation in effect is induced. But if the steel be heated *above* the lowering temperature, it turns out that the hotter we get it before we start the cooling, the lower will come the recalescence points. Extending the time at heat has the same result. For obvious reasons no analogous phenomenon is to be seen with the decalescence points. The carbon content also has a large influence on the critical points of the various steels. In fact, up to 0.35 per cent carbon there are three transformations; it is assumed that the two upper ones coalesce as the carbon content is increased, while the lower one remains. By referring to a standard diagram known as the Roberts Austen chart, the number and approximate location of critical points for a steel of any carbon content may be obtained by simple inspection.

AFTER a material has been heated to its melting point, additional heat must be supplied to bring about the actual melting. While this change of state is being effected, no rise in temperature occurs; for the passage from the one state to the other involves the doing of certain work, which in turn means the absorption of heat, to an amount often surprisingly large. The same state of affairs exists again at the boiling point; and indeed, so much is familiar to all of us. Most of us, however, do not know that in addition to the melting and the boiling points, many substances possess other thermal critical points, at which increase of temperature is suspended while any heat supplied goes to work to effect some physical change in the material. It is in fact at these critical points and by such absorption of heat that hardening and tempering of metals are carried on; so that in a very real sense, as our title suggests, the heat supplied while the metal remains at the critical temperature is "put in the bank," to be drawn out in the form of improved metallurgical properties. Mr. Collins puts before us the story of just how all this takes place.—THE EDITOR.

It is not difficult to understand in a general way what happens at the critical points. Allotropy is the capacity to undergo, without change of chemical composition, an alteration of chemical and physical properties. The occurrence of pure carbon as diamond, coke and graphite is an example. The explanation is doubtless to be sought (see SCIENTIFIC AMERICAN, May 15, 1920: *The Architecture of the Atom*, and May 29, 1920: *The Architecture of the Molecule*) in a rearrangement of the electrons about the nucleus of the atom. Iron, too, exists in at least three allotropic forms; and passage from one of these to another is marked by evolution or absorption of heat, giving rise to the critical points we have noted. The three forms are designated alpha, beta and gamma iron.

Alpha iron is ordinarily called ferrite. It is soft, ductile and magnetic; it will not dissolve carbon. Beta iron, which has no better name than this, is of higher specific gravity than the ferrite, very hard, feebly magnetic, and to a limited extent capable of absorbing carbon. Gamma iron, or austenite, is of still higher specific gravity, non-magnetic, softer than beta iron, harder than alpha, and absorbs carbon.

In addition to the three simple forms, several others interest us here. Cementite is carbide of iron, Fe_3C, containing 6.67 per cent carbon in *chemical union* with the iron. It is extremely hard, and about two-thirds as magnetic as pure iron. It usually tends to break up into iron and carbon, in the forms of ferrite and graphite. Pearlite is a combination *(not chemical)* of cementite and ferrite, usually assaying about 0.90 per cent carbon. Martensite is a solid solution (a familiar phenomenon to the metallurgist) of cementite, in iron that is partly beta, giving hardness, and partly alpha, giving magnetism. It is the condition in which the steel is caught in rapid quenching from the austenitic stage (which exists above the higher transformation point), and is the first transition stage out of this condition. As the steel is caught at still lower temperatures, it forms first troostite, then sorbite—forms which we need only identify by name—and finally pearlite. A steel in cooling does not change wholly from one of these forms to the next, but is transformed gradually, so that if quenched at an appropriate point between the two critical temperatures it may be, for instance, partly austenitic and partly martensitic. Or if the rate of cooling is changed the resulting constituents are different, running the course from martensitic from rapid cooling to pearlite from slow cooling.

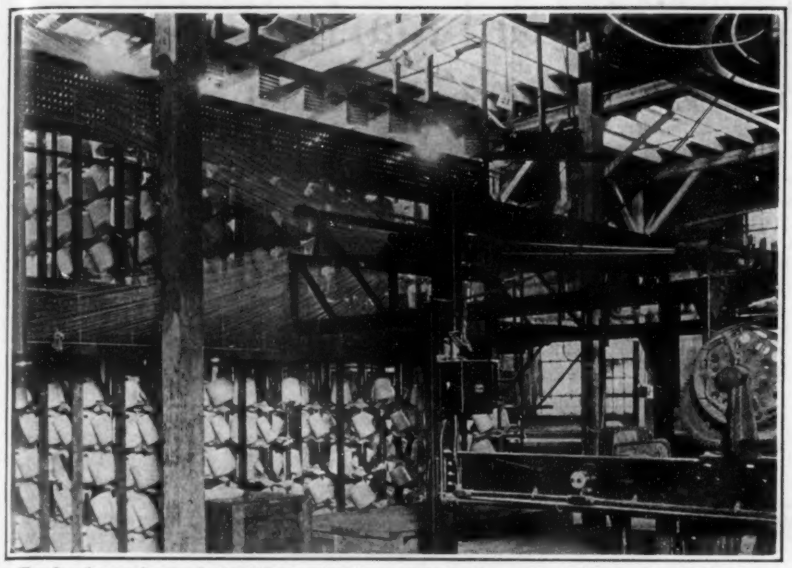
Steel containing 0.90 per cent of carbon—the amount iron will dissolve under ordinary conditions—is known as eutectoid steel. The statement is sometimes made that it is not possible to harden steel of less than eutectoid proportions. If one means complete hardening this is correct; but even with low-carbon steels, quenching from temperatures above the upper recalescence point gives martensite and a partial hardening.

It seems probable that hardening is effected by the retention of the iron in the beta condition, after a temperature has been reached in cooling at which transformation out of this state would ordinarily have taken place. The presence of carbon increases the amount of beta iron which thus resists transformation. So the more carbon the more beta iron and the greater degree of hardness—until the eutectoid ratio is reached; when, under proper conditions, the entire body of metal passes from the gamma to the beta form, and is held in the latter form by quenching.

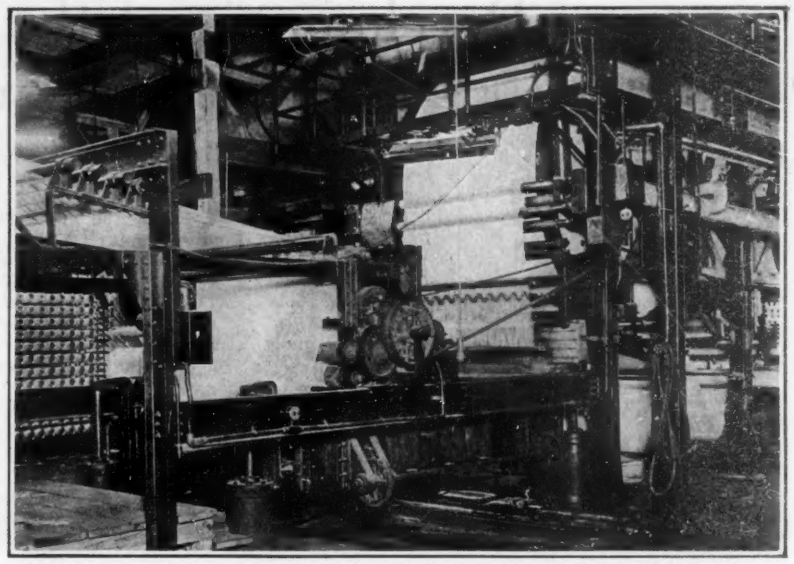
In steels of low carbon content—0.30 per cent and less—there are three wholly distinct critical points, the usual upper one being represented by two transformations which we may here call upper and middle. As the metal cools to the highest of these, the orderly contraction is superseded by a sudden expansion, followed again by contraction after the critical temperature is passed. Electric conductivity, low at high temperatures, increases after the transformation and continues to go up until normal conductivity is reached at atmospheric temperature. Above this upper critical point the grain is octahedral, but below it becomes and remains cubical. There is a sudden increase in tensile strength, and a decrease in the power of absorbing carbon. The structural change is from the solid solution of austenite to a mixture of austenite and beta iron.

There is no further structural change at the middle transformation point; but as the steel passes through this it suddenly becomes strongly magnetic, and continues to increase in magnetic strength as cooling continues. At the lower change-point the remaining austenite is transformed into pearlite and ferrite. Expansion occurs, magnetic power increases, and absorption power for carbon is lost. The important change is that of austenite to pearlite, which makes it possible to refine the steel by heat treatment, because on being heated through its critical range, the steel is changed from a coarse aggregate to a fine, almost amorphous,

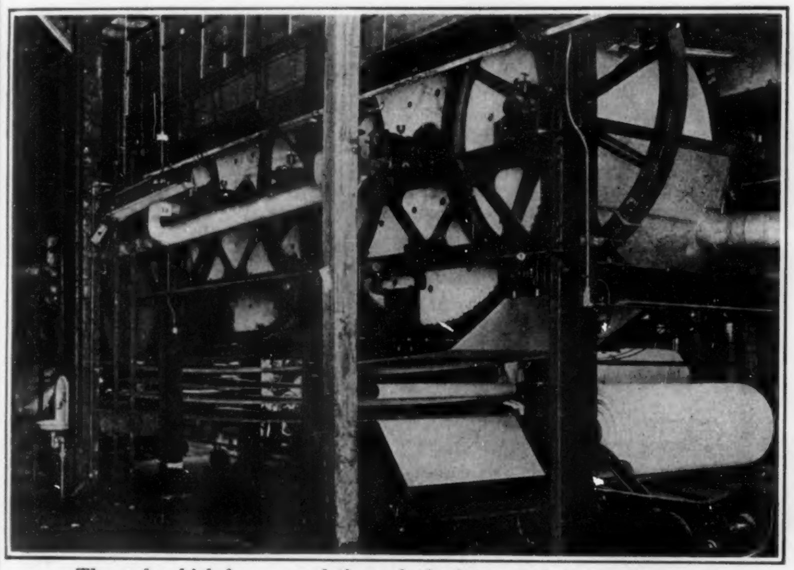
(Continued on page 376)



Rack of spools, each feeding a single cord into the web. This is the beginning of the new process for making tire fabric.

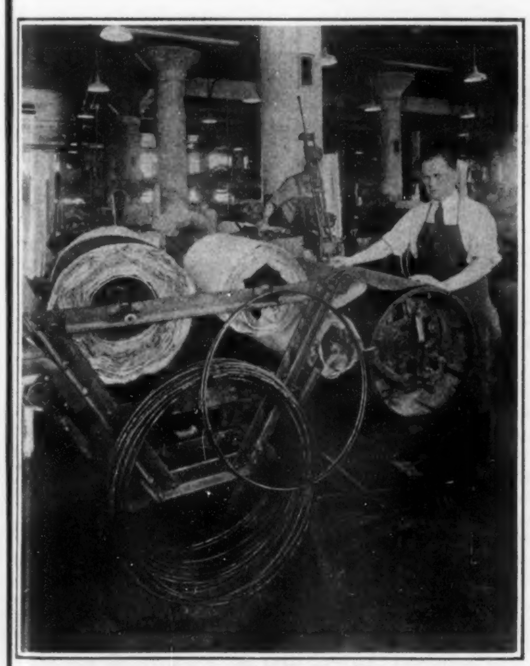


Web from spools passing over rolls and through latex tank at bottom where the cords are impregnated with the liquid latex

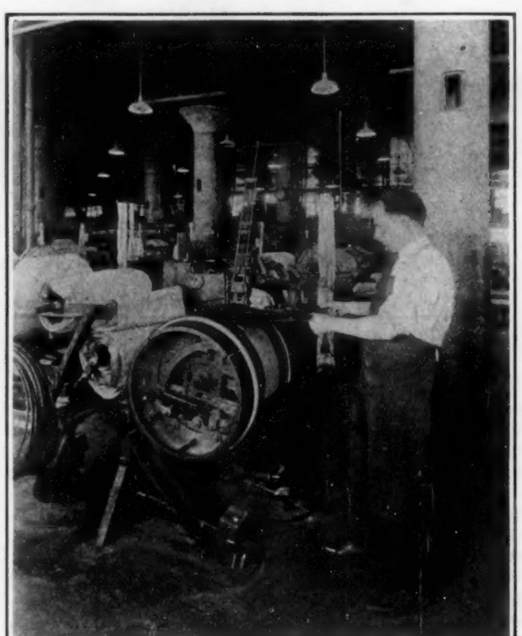


The web which has passed through the latex tank is roved around drying rolls

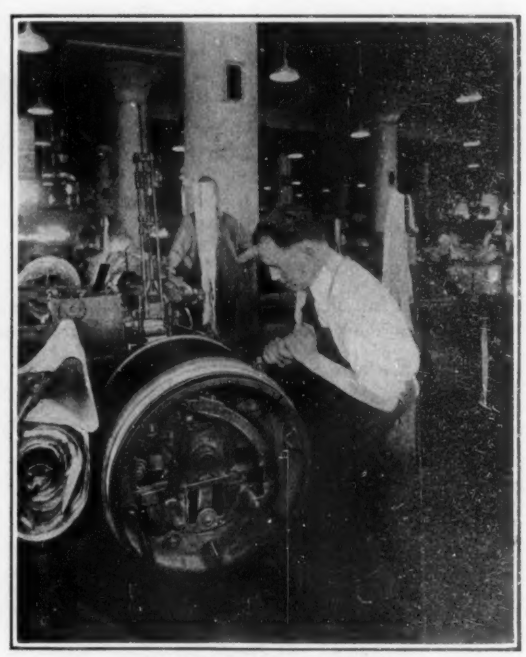
Beginning of the building of the cord tire by the "flat band" process of manufacture



Starting the band ply



Applying the tread



Putting on the wire bead

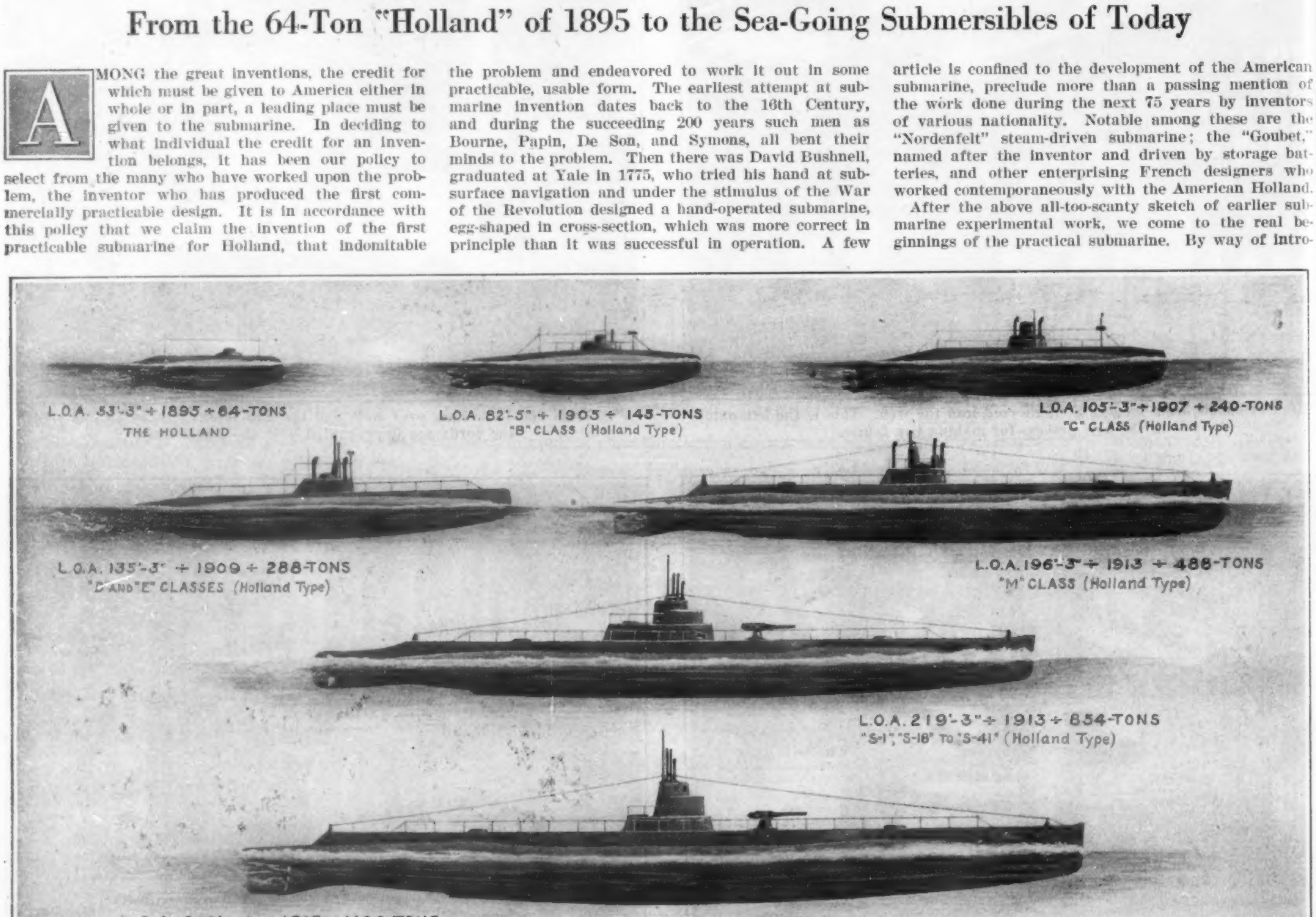
MAKING CORD-TIRE FABRIC BY ONE OF THE NEW WEB-CORD PROCESSES

Development of the American Submarine

From the 64-Ton "Holland" of 1895 to the Sea-Going Submersibles of Today

AMONG the great inventions, the credit for which must be given to America either in whole or in part, a leading place must be given to the submarine. In deciding to what individual the credit for an invention belongs, it has been our policy to select from the many who have worked upon the problem, the inventor who has produced the first commercially practicable design. It is in accordance with this policy that we claim the invention of the first practicable submarine for Holland, that indomitable the problem and endeavored to work it out in some practicable, usable form. The earliest attempt at submarine invention dates back to the 16th Century, and during the succeeding 200 years such men as Bourne, Papin, De Son, and Symons, all bent their minds to the problem. Then there was David Bushnell, graduated at Yale in 1775, who tried his hand at subsurface navigation and under the stimulus of the War of the Revolution designed a hand-operated submarine, egg-shaped in cross-section, which was more correct in principle than it was successful in operation. A few article is confined to the development of the American submarine, preclude more than a passing mention of the work done during the next 75 years by inventors of various nationality. Notable among these are the "Nordenfelt" steam-driven submarine; the "Goubet," named after the inventor and driven by storage batteries, and other enterprising French designers who worked contemporaneously with the American Holland.

After the above all-too-scanty sketch of earlier submarine experimental work, we come to the real beginnings of the practical submarine. By way of intro-



Thirty years' development of the American submarine, from the little 64-ton, 7-knot "Holland" of 1895 to the fast sea-going type of 1924, of 2164 (surface) displacement and 22½ knots speed

American inventor who has given his name to a type of submarine which for 30 years past has been the pattern upon which, with various modifications, the submarines of the world have been modeled. The story of its development, as far as the United States Navy is concerned, is shown in the accompanying series of drawings, which, since they are on the same scale, serve to show the steady growth in size from the "Holland," the first practicable boat, designed by Holland for the U. S. Navy in 1895, to the impressive sea-going "Fleet Submarine," designed by the Bureau of Construction and Repair, and launched in 1924. In claiming for Holland the credit for having built the first practicable submarine, we are not unmindful of the fact that many a forward-looking and ingenious inventor before his day had grasped the importance of years later came the experiments of Fulton, of steamboat fame, who produced in the "Nautilus" a submarine of approximately cigar shape, which, like Bushnell's design, was entirely hand-operated. In these early attempts the tactics, if we may call them such, consisted in approaching the wooden warship under water, attaching an explosive with a time-fuse or some other automatic firing mechanism, to the submerged portion of the hull and so sinking her. Fulton succeeded, in one of his tests, in blowing up an old "shallop." Fulton had a thorough grasp upon the principles of the submarine, and had French or British or private interests given him the backing that was necessary, it is our opinion that he might have antedated the first steam-driven submarine by half a century.

Limitations of space and the fact that the present duction we quote the following from the U. S. Navy Appropriation Bill of 1893: "Submarine Torpedo Boat —For building a submarine torpedo boat and conducting experiments therewith $200,000 to be taken from the balances of appropriations on hand July 1, 1893, etc.," which provision was made with a view to encouraging inventors to devote their skill to the submarine problem. The following requirements were to be met: Safety; facility and certainty of action when submerged; speed on the surface; speed when submerged; endurance; offensive power; stability; visibility of object to be attacked.

The principal designs sent in were those for the Baker boat, the Holland boat and the Lake boat. The Baker design, cigar shaped, was 40 feet long and 14 feet in beam, and of 75 tons displacement. The boat was

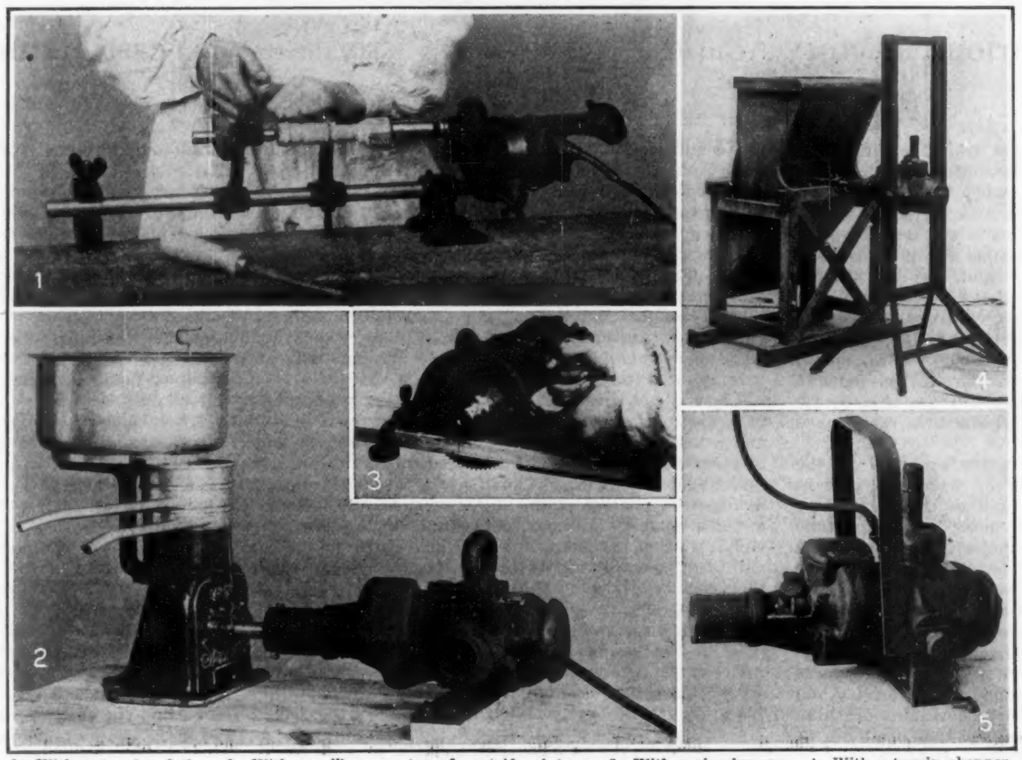
driven by steam at the surface and by electric motor when submerged.

Mr. Lake failed to get his design accepted but in 1894 to 1895 he built a boat, 14 feet by 5 feet, of timber and provided it with outside driven wheels and chain gearing by which on submerging it could travel on the bottom. Mr. Lake was a typical intelligent and indefatigable American inventor. Down through the years he built boat after boat until he had brought his system to a stage at which he secured contracts and built many of his type for the U. S. Navy as well as for other countries.

Mr. Holland's first effort took shape in the famous "Holland No. 1," built in the year 1875, and for a period of several years Holland kept pegging away at the problem until his designs were finally approved and in 1896 the keel of a boat was laid which was launched and known as the "Plunger." The first of our drawings shows one of the efforts of this early period. It was 53 feet 3 inches long and displaced 64 tons at the surface. The "Plunger," 85 feet in length, had a maximum diameter of 11½ feet and a surface displacement of 140 tons. The boat, as first designed, was uninhabitable because of high temperature and for several years the completion of the "Plunger" was abandoned. Meanwhile the Holland Company designed and built at its own expense the "Holland No. 8." This boat was longer than the one herewith shown and was of 75 tons surface displacement. It was driven by a gasoline engine of 50 horsepower on the surface and by an electric motor fed by storage batteries. She carried a bow torpedo tube and made seven knots on the surface and 5½ knots when submerged. After exhaustive experiments the United States authorities authorized her purchase for $150,000.

Some ten years later there was built for our Navy what is known as the "B" Class, in which the length had gone up to 82 feet 5 inches and the surface displacement to 145 tons. The speed was about nine knots on the surface and seven knots submerged. The cruising radius was 850 miles and she carried ten officers and men.

Two years later came "C" Class, generally similar to the "B" Class but larger, with an over-all length of 105 feet 3 inches and a surface displacement of 240 tons. The radius was increased to 900 miles; the personnel was the same, but an additional torpedo tube was added, the "B" Class having one and the "C" Class two tubes.



1: With a turning lathe. 2: With a milk separator of centrifugal type. 3: With a circular saw. 4: With a turnip chopper. 5: With a drill

Five typical applications of an all-around electric motor for the household developed in Germany

In 1909 appeared the first of the "D" and "E" Classes, the length of the "D" Class being 135 feet 3 inches and the displacement 288 tons, while in the larger boats of the "E" Class the displacement rose to 350 tons. The "D" boats were good for a cruising radius of 1250 miles and the "E" boats could cruise for about 1700 miles. The respective speeds at the surface and submerged of the "D" boats were 13 knots and 9.5 knots. They carried fifteen officers and men and were fitted with two torpedo tubes.

In the next class selected for illustration, the "M" Class, the length was 196 feet 3 inches and the surface displacement was 488 tons. These vessels marked a considerable advance in every particular. They were capable of cruising several thousand miles at eleven knots, and they had a speed of fourteen knots on the surface and 10.5 knots submerged. They carried a crew of 28 and were provided with four torpedo tubes.

In 1913 was designed the famous class known as the "S" boats. These, which like their predecessors are of the general Holland type, are 219 feet 3 inches in length and run about 854 tons displacement. The figures given apply to a large number of boats numbered 18 to 41. Their motors are of 1200 horsepower for surface travel at fifteen knots, and they have a speed submerged of eleven knots. They are credited with a radius of about 5000 miles at eleven knots. Each boat carries four torpedo tubes and the complement is 37 officers and men. The date of the design is 1913.

The next or "T" Class designed in 1915 are much larger boats. The length over-all is 269 feet and the displacement is 1106 tons at the surface and 1520 tons submerged. They are credited with a maximum speed of twenty knots on the surface and submerged they can do eleven knots. The radius of action is from 7000 to 9000 miles.

The last boat shown in our drawings brings us up to the present date. There are three vessels of this type under construction. They are of the "Sea-going" or "Fleet" type and are of sufficient size, power, speed and radius of action to accompany the fleet on the high seas and engage in a first-class battleship engagement. They are known as the "V" Class. "V-1" was launched last summer and will shortly be in commission. The length has risen to 341 feet 6 inches and the surface displacement is 2164 tons. These fine boats were designed by the Bureau of Construction and Repair of the Navy. They embody the most up-to-date practice both in construction and equipment; but for the present the Bureau does not wish to give out any detailed description. They are driven by oil engines and are expected to show a speed of about 22.5 knots on the surface and ten knots submerged. They are among the largest submarines built or projected, and it is believed that in these vessels we shall be provided with seagoing submarines fully equal to the arduous duties which must necessarily fall to such boats. After they have proved themselves, it is to be hoped that Congress will make liberal appropriations for the construction of as many as the General Board of the Navy recommends.

Temperature Variations in Plants

RECENT investigations have established the fact that, contrary to general belief, the temperature of plants is not always the same as that of the surrounding medium and that different parts of the same plant may have different temperatures. As a rule, the temperature variations are so small that it is difficult to determine them with the thermometers commonly in use for measuring temperatures. Fairly good results may be obtained with more sensitive thermometers, calibrated to show variations of one-tenth of one degree. The small and pointed cylindrical bulb of the instrument is carefully pushed into the tissue of which the temperature is to be ascertained. An instrument with a flattened bulb is used to measure surface temperatures.

In some cases a differential thermometer is used which has two bulbs, each enclosed in a thin-walled container. If one of the containers, for instance, is filled with dry grains of some cereal, the other with grains of the same cereal, ready to germinate, it will be found, that the germinating grains have a considerably higher temperature than the dry.

Much more precise measurements may be made with thermo-electric needles connected with a galvanometer. One of the needles is inserted in the tissue of the plant, while the other is exposed to the air temperature. With this instrument the difference between the two temperatures may be ascertained within the three-thousandth part of one degree.

The development of heat in plants is believed to be due to the accumulation and digestion of reserve material, principally starch, which, in the presence of amylase is transformed into sugar. In many instances, marked differences between the temperature of plant tissue and that of the surrounding air may be attributed to the fact that under the influence of sunlight the plant tissue is heated from the outside. The trunks of trees, for instance, become gradually heated during the day and, being surrounded by bark which is a good heat-insulator, they retain the heat much longer than the outside air, the temperature of which quickly drops considerably toward evening. Differences of twenty or more degrees have frequently been observed between the temperature in the interior of tree trunks and that of the surrounding air.

The inner temperature of plants is principally reduced by two causes, the cooling effect of the evaporation of moisture through the leaves and the withdrawal of heat by the underground water around the roots.

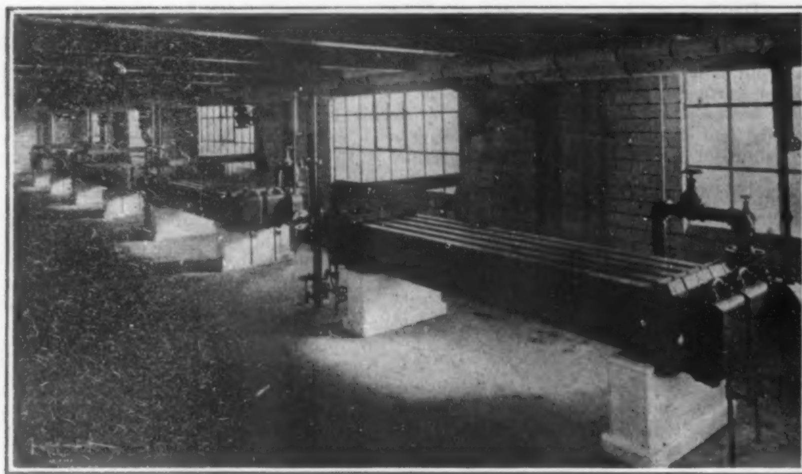
Not all parts of the same plant have the same temperature. Measurements taken in the long stem of a lily showed that the temperature near the ground was slightly lower than in the middle of the stem, remaining higher in the upper half and rising markedly near the top.

During their flowering season plants often develop temperatures considerably higher than that of the surrounding air in their blossoms. In Victoria Regia this difference often reaches 10 degrees, in Arum and other swamp plants from 2 to 15 degrees. The blossoms of the Italian Arum, which open toward evening, show the highest temperature at midnight. Then the temperature gradually becomes lower, reaching normal soon after sunrise.

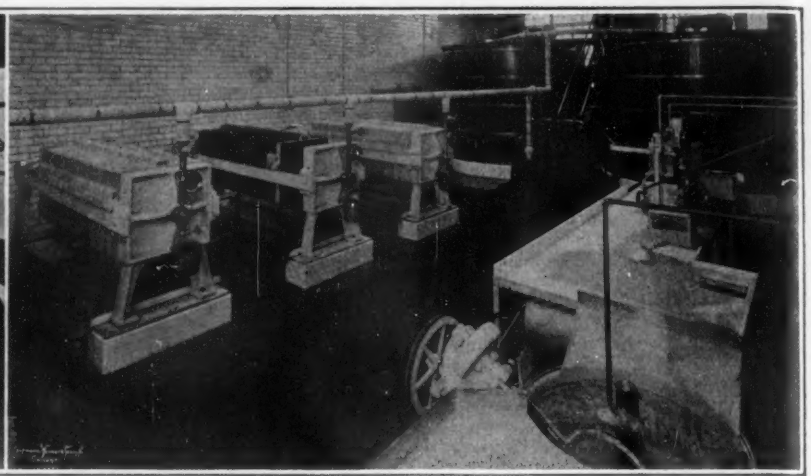
It is believed that the rise of temperature in flowering plants is due to the greater intensity of oxygen absorption during the vigorous process of florescence and beginning fruit forming.

An Electrical Jack-of-All-Trades

GERMANY, the land of specialization, is rather unaccountably responsible for one of the neatest all-around tools that we have seen for a long time, in the "manifold electric friend of the family" (translating literally its long-winded German trade name) illustrated on this page. The little electric motor which forms the chief part of the outfit is mounted on a horizontal shaft. If we remove the motor from this shaft and screw a drill to the barrel that transmits the rotation of the motor, we get the handy little drill of the lower right-hand view, which is easily manipulated in any position. Very little modification from the drill set-up results in an electric screw-driver. If we remove the drill and clamp the motor to the table, we open up a whole chapter of applications, according to what auxiliary instrument is coupled on the motor. Among the suggestions illustrated are those as a lathe and as a circular saw; and an interesting variant on the latter application is bevelling. Suggestions which our German contributor makes without photographic support include the use of the motor with filing and polishing tools. Finally, with the use of a little intermediary gear which, we judge, comes with the motor, this source of power may be coupled up to chopping mills, churns, and a wide variety of small household machines. For household use as well as general shop applications this seems a very well-worked-out assembly.



The mash going through the cooling coils



Filter presses, pressing the yeast

Microscopic Vegetable Growing

The Curious, Factory-Adapted Agricultural Processes of Yeast Manufacture

By Ralph Howard

WHAT is this grayish white, square cake, that comes sold wrapped in tinfoil, and that our mothers, when bread was baked at home, used to use in leavening bread? What power is contained in this mass that makes it possible for it to convert a soggy mass of dough into a light, swollen product which is afterwards baked to give a palatable, easily digestible, food product, the loaf of bread, which has aptly enough been called, the staff of life? Is it a chemical that is contained in this wonderful substance? Does it obtain its potency from its chemical properties? Or what other agency is hidden therein that is responsible for the effects that it produces in the kitchen and elsewhere?

It is probable that it has never occurred to the average person who uses yeast or who has come in contact with it in one way or another that here is no mere chemical, no inert, lifeless mass, but a multitude of living cells. Yeast is living matter. It is composed of myriads of micro-organisms, yeast cells as they are called, which are alive with energy and which are ready to turn their energy to useful purpose, useful to man, when placed in the proper conditions. It is truly one of the most marvelous of modern achievements that it has been possible for man to harness the energy possessed by microscopic, living matter and use it to produce certain, important results for him.

Yeast is a vegetable of the fungus type. It grows by a process of budding. The individual cells of the yeast plant are egg-shaped and possess a diameter of approximately 1/3600th of an inch. In one pound of yeast there are billions upon billions of these plants pressed tightly together. In a three-cent cake of yeast, for example, it has been estimated that there are 22 times as many yeast cells as there are people in the entire world.

The most peculiar part of the yeast cell growth is the manner in which a single cell grows by budding, adding to itself other cells until quite a cluster has developed. Then after a group has formed, a ripening process sets in, which results in the groups gradually breaking up into individual cells.

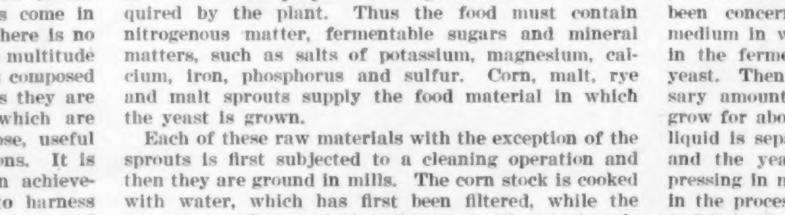
The manufacture of the cake of compressed yeast is by no means a simple process. The process of making yeast consists essentially in cultivating the plant. In other words, yeast being a vegetable, is grown and in growing the conditions must be very carefully regulated, just as in the case of any other choice plant.

In growing any plant there are certain elementary considerations which must be watched in order to obtain a prime growth of the plant. Thus the seeds from which the plant grows must be carefully selected so that a strong, healthy growth is obtained. Furthermore, the soil or rather the food media on which the plant grows should be such that it finds the proper nutrients for ideal growth and development. Finally, the conditions under which it is grown, such as the temperature, the light, moisture supply, must all be so arranged that sufficient of each is present. Under such circumstances a prize-winning plant is obtained.

Hence, in accordance with the manner in which the growing process is controlled different varieties of yeast are obtained, much in the same manner as different types of cabbages, potatoes and other vegetables are obtained by varying the conditions under which they are cultivated. Some of these yeasts are suitable for making bread, and some are not, but can be employed for other purposes.

Yeast is not grown in soil, as are other plants, but in a medium which is made from grain grown in soil and which is carefully controlled and composed so that it contains the proper food ingredients that are required by the plant. Thus the food must contain nitrogenous matter, fermentable sugars and mineral matters, such as salts of potassium, magnesium, calcium, iron, phosphorus and sulfur. Corn, malt, rye and malt sprouts supply the food material in which the yeast is grown.

Each of these raw materials with the exception of the sprouts is first subjected to a cleaning operation and then they are ground in mills. The corn stock is cooked with water, which has first been filtered, while the sprouts are just cooked and sent to the mash tub. Then the ground barley malt, the ground rye, the cooked ground corn and the cleaned malt sprouts are added to the mash tub together with additional water.



Glass models showing growth of yeast colonies

The mash tubs are huge copper tubs which are kept spotlessly clean. After the corn is cooked, a process which has for its purpose the rupturing of the starch granules so that they can be acted upon by the enzyme, diastase, contained in the malt, the corn is dropped into the mash tub. Then the cleaned ground malt is added and the mixture is kept at the proper temperature until all of the starch has been converted into sugar by the diastase. Malt sugar is obtained in this manner.

The other grains are then added, and the whole mass is thoroughly mixed and then is pumped into the souring tub.

Yeast has been found to grow best in an acid medium. The necessary acidity for the growth of the yeast plant is obtained in the souring tub by the addition of another organism which gives rise to a lactic acid fermentation. This organism is known as the lactic acid bacillus. The mash in the souring tub is soured by the growth of this bacillus. This has also the effect of purifying the mash and extracting valuable food material from the grain. At the end of eighteen hours the mash is sterilized and pumped to the filter tub.

After being filtered, the grain extract which contains all the nutritive matter is sent to the large copper fermentation tubs. Up to this point the process has been concerned with the preparation of the food medium in which the yeast is to grow. The first step in the fermentation tub is to add a pure culture of yeast. Then air is blown through to supply the necessary amount of oxygen and the yeast is allowed to grow for about 18 hours. Then the greater part of the liquid is separated by means of centrifugal separators and the yeast is removed from the residue by dry pressing in multiple plate filter presses. The next step in the process is to mix it so as to insure uniformity and it is there cut into pounds for delivery.

During the entire operation the greatest of care must be taken to control all the various factors that determine the quality of the finished product, and samples are taken at regular intervals during the process for analysis. One of the prime requisites of the manufacturing process, which will result in the obtaining of a yeast of high quality, is absolute cleanliness.

The interesting point about the fermentation process in which the yeast is grown is the manner of this growth. A single yeast plant floating in a proper food medium will show a slight projection on one side after a period of 20 minutes to half an hour. This projection or bud enlarges and soon is nearly as large as the original cell. Then this bud puts out a bud itself and after a while some 20 to 30 buds are attached to each other, all in one mass. At this point the budding stops and the plant starts to ripen. All of the buds finally separate from each other and float around singly.

Pressed yeast is a friable mass, containing about 30 per cent of solids of variable composition and about five to ten per cent ash. Good baking yeast has a pleasant taste and odor, and is neither wet nor crumbly. Yeast contains protein matter, nucleic acid which is food for the brain, phosphorus, which is nerve food, calcium salts for the teeth and bones, glycogen for energy, fat for heat and iron for the blood. It contains enzymes and vitamine.

The principal use of yeast is as a leavening agent, that is, it is employed to raise the dough from which

bread is baked. Bread contains various ingredients, such as water, malt, lard, sugar, milk, salt, flour and finally yeast, each of which has a function to perform. Flour is, of course, the main ingredient and gives the bread its substance. Water dissolves salts, swells the starch, aids in the formation of the color of the bread and renders it more digestible. The malt supplies yeast food, improves the flavor of the bread and adds to its nutrition. The lard improves the keeping qualities of the bread, makes a soft velvety crumb and keeps the bread moist. Sugar sweetens it, supplies gas to raise the dough, gives the color to the crust, is a food for yeast and adds food value. Milk improves the flavor, acts as a shortening and gives food value. Salt retards fermentation, adds to the flavor, develops bread odor and toughens the gluten.

There are five functions of the yeast in bread. First it serves to raise the dough, then it matures the glutens, develops fragrance, adds to nutrition and supplies the vitamin.

The leavening action of yeast is due to the action that it has on sugar, causing the fermentation or decomposition of the latter with the evolution of carbon dioxide gas. The effort of this gas to escape from the glutenous dough causes the loaf to expand until it becomes light and porous.

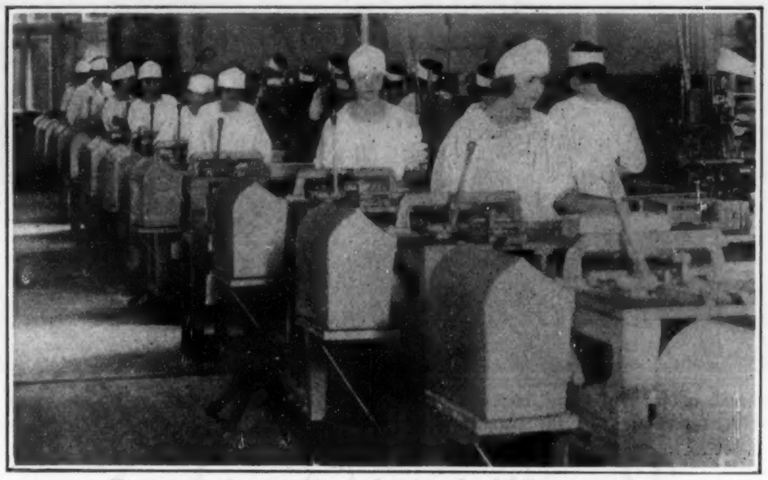
But in addition to this function, yeast also possesses another which may be said to be of even more importance, and that is, its action in maturing the gluten, rendering the bread more digestible, wholesome and nutritious. How is this effected?

Yeast contains a class of substances that are known as enzymes. These enzymes bring about certain chemical changes, their mere presence guiding and controlling the action of the dough.

There are four important enzymes in yeast. The first is maltase which possesses the power of converting malt sugar into a directly fermentable, simple sugar, glucose. The second is invertase which converts beet or cane sugar in the dough into glucose. The third is zymase, which is the enzyme that attacks the simple sugar, glucose, and converts it into carbon dioxide and alcohol. The fourth is a group of enzymes known as proteases, which possess the power of acting on the protein found in the dough, resulting in the mellowing, ripening and maturing of the gluten in flour. The net effect is a bread which is easily digestible and assimilable by the human system.

Yeast therefore not only leavens the bread, giving a light loaf, but it also partially digests the gluten in it so that a part of the work that has to be done by the digestive system is performed before the bread is eaten. It also adds nutritive value to the bread due to the glycogen that it contains and is also a source of vitamin B, which is an important constituent of food, as its absence from it gives rise to malnutrition, general debility, loss of appetite and makes the individual easily susceptible to the invasion of disease germs.

One of the most important recent developments in the use of yeast in the baking of bread is known as the no-dough-time process. By this process, in which 2.5 to 3 per cent of yeast is employed based on the weight of flour used, the usual time allotted to the fermentation of the dough is omitted. The dough goes directly from the mixer into the divider. The setting of the dough is carried out at a higher temperature in this process and the proof box is also maintained at a higher temperature than in the old process in which a certain amount of time was set aside for fermentation. The result is a fine bread of appetizing flavor, retaining its freshness for a longer period of time and requiring from one and one-half to two hours for the total baking process in place of from five to seven hours as heretofore.



Yeast-wrapping machines, showing the feeding operation

While the use of yeast in the baking of bread forms one of the largest applications to which this product is put, nevertheless, there are other uses for yeast as well. A recent development has been in the use of yeast for therapeutic purposes. Many scientific investigations have been made along these lines and very interesting results have been obtained. It has been shown that yeast possesses valuable properties as a medicament or therapeutic agent in the treatment of constipation. It is not a drug and is not in any way possessed of habit-forming properties. It can be used with success in treating various gastro-intestinal troubles.

Another one of its uses is the treatment of skin diseases, such as acne, boils, carbuncles and the like. The internal use of yeast seems to have a marked effect in removing the conditions in the system which give rise to these difficult, uncomfortable and distressful ailments. It is also used for the treatment of cases of general debility, malnutrition, loss of appetite, and the like. The beneficial action of the yeast in these cases is due to its content of vitamin B, for to the lack of this vitamin is generally ascribed the prevalence of such conditions. Another interesting medical use of yeast is in the treatment of rheumatic conditions. It is claimed that good results were secured by the administration of yeast.

Yeast is also the source of many medical preparations of importance. Chief among these is yeast nucleic acid. This substance is used for the purpose of increasing the number of white blood corpuscles in the body. It is injected subcutaneously. The yeast is treated with alcohol and solutions of salt in order to isolate this substance.

It has also been found that yeast possesses the property of combining with basic dyestuffs; that is, the yeast protein does. Then treatment with superheated steam at a temperature of 125 degrees Centigrade fixes the dye. The result is a series of useful preparations with such antiseptic dyestuffs, as methyl violet, auramines, and safranines. The combination of yeast protein with methyl violet yields the product known as pyoktanin, which has been used in the prevention and treatment of the foot-and-mouth disease in cattle. An astringent preparation is obtained with yeast and tannin, as well as a uric acid eliminant. Certain forms of yeast have been suggested for use in the extraction of their fatty content. Yeast for this purpose is cultivated in a food medium of molasses supplemented with nutrient salts. The resulting press cake contains 18 per cent fat, 31 per cent proteins and 43 per cent carbohydrates. The oil is edible; the hardened product may be used as soap stock.

By treating waste yeast with formaldehyde a bakelite-like product can be obtained. The product is dried and ground with tar, sulfur or pigments. Then it is molded into shape at 90 degrees Centigrade and 3000 pounds pressure. Products resembling rubber and leather can be obtained from yeast, formaldehyde and glue. However, by far the greater quantity of yeast produced is employed in baking, and more recently for direct consumption, to counteract the effects of various skin diseases and infections. The industrial uses of yeast are important mainly in that they provide a means for getting rid of low-grade yeast.

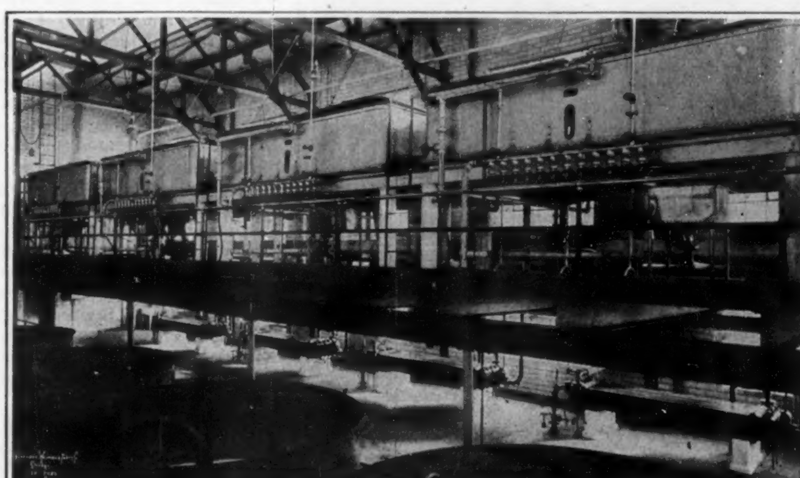
Two Pecks of Sugar from One Bushel of Corn

A BUSHEL of corn weighs about sixty pounds, and about thirty-three of these pounds are accounted for by starch. It is not difficult to extract the starch from corn and a way to convert this starch into sugar economically has long been sought. Man asked the advice of his stomach first. That organ is an old hand at changing starch into sugar, but man has not until very recently found the secret. Now comes the announcement that H. C. Gore, of the United States Bureau of Chemistry, a subsidiary of the Department of Agriculture, has found a way to get thirty-three pounds of sugar from each bushel of corn. Mr. Gore is chemist in charge of the Bureau of Chemistry's Fruit and Vegetable Utilization Laboratory.

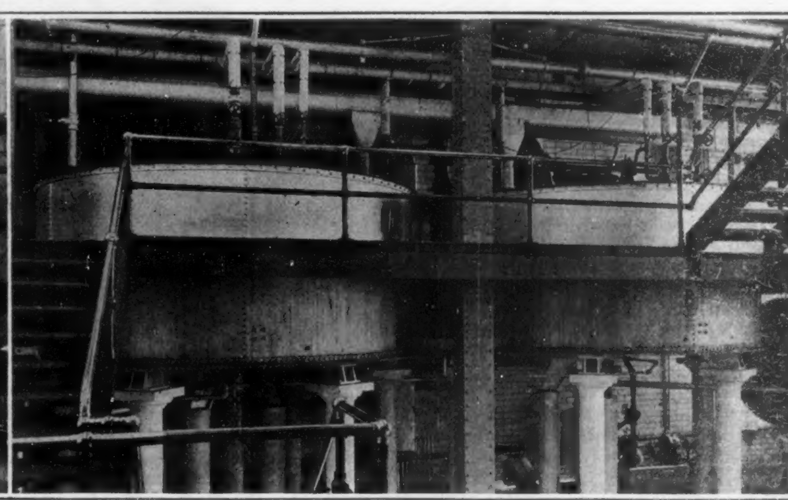
The common white granulated grocer's sugar we nearly all eat is, technically speaking, only one of the sugars. The food chemist calls it sucrose. In addition to sucrose there are the well-known forms of sweeteners, glucose and maltose. These are also sugars, but they are not sucroses. Maltose, the product which is to be made from corn, is somewhat sweeter than glucose; but only about three-fifths as sweet as sucrose.

Briefly, the process consists of mixing the cornstarch with warm water and malt and then putting it through the same processes which ordinary "sugar" goes through. The new sugar looks a little like confectioner's sugar and tastes like Christmas candy.

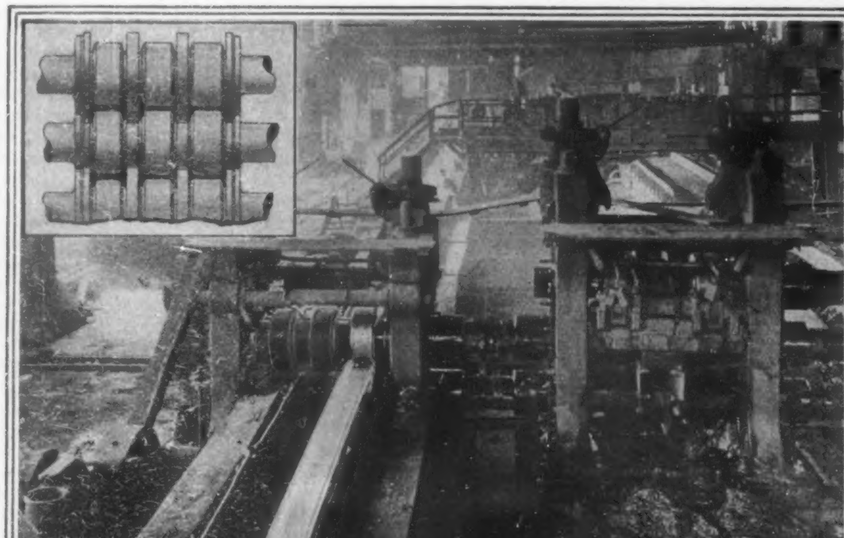
Mr. Gore, the discoverer of the new process, states that the significance of this work is that it tends to make us less dependent on foreign countries for our sugar supply and at the same time will, when developed industrially, furnish another outlet for the corn grown in this country.



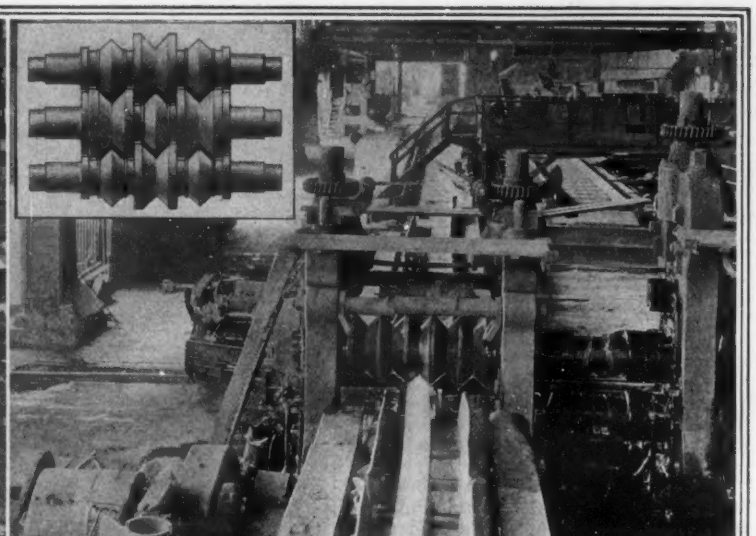
Filter tanks—copper above, white enamel below



Mash tubs in which corn is cooked to serve as food for growing yeast



A twelve-inch, 44.3-pounds-per-foot channel in its finishing pass through the rolls. The insert shows a set of three-high roughing rolls for forming I-beams



A 6-in. by 6-in. by ½-in., 19.6-pounds-per-foot angle passing through the rolls. The insert shows a set of three-high rolls for finishing angles

The Story of Steel—X

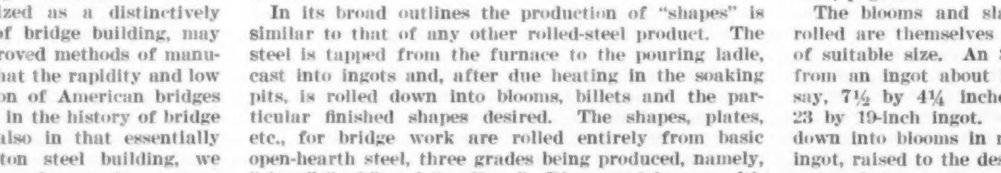
Rolling Steel Shapes for Buildings and Bridges

THE steel bridge and the composite steel-masonry building are two forms of construction which are recognized, the latter as having originated and been developed in America, and the former as possessing certain outstanding characteristics which have caused it to be recognized as a distinctively American type. Particularly of bridge building, may it be said, that it is to the improved methods of manufacture and shop management that the rapidity and low cost of construction and erection of American bridges was due during the greatest era in the history of bridge construction in America. So also in that essentially American structure, the skeleton steel building, we have developed, under the urge of necessity, a type which is distinctively our own and bids fair in these later days to become the established type in such cities of the world as are obliged by geographical and other conditions to mass a large working population upon a limited area of ground.

Although the distinctive age of American bridge building, above referred to, has passed and the pressing necessities, at least for bridges of the larger type, have been met, the tall office building and the far-spreading and many-storied factory have continued to grow at an ever increasing rate. To meet that growth there has been a corresponding increase in the capacity of the shops which turn out that kind of steel building material which is known by the generic name of "shapes," under which are included angle-irons, T-irons, I-beams, Z-bars, channel irons, etc. It should be noted that it is customary to speak of "heavy" and "light" structural shapes, the former including all beams, angles, etc., having one leg or web of three inches and over and a thickness of one-quarter inch and over, which are rolled for structural or fabricating purposes; the "light" shapes and small angles being such as are rolled for the manufacture of bedsteads, agricultural implements, fences, or for other fabrication having a smaller section than that above given. It will readily be understood that in view of the growth of the country both in population and industrial development, the production of heavy and light structural shapes runs to large figures. In 1914 the total output was 2,031,124 tons. Due to the impetus of the war, the total rose in 1916 to 3,029,964 tons. It dropped in 1921 to 1,272,624; but in 1923, after a remarkably rapid increase, structural shapes showed an output of 3,405,197 tons, the greatest in the history of this industry. It is needless to say that practically the whole of this material was rolled from steel, 1448 tons only being rolled from iron.

In its broad outlines the production of "shapes" is similar to that of any other rolled-steel product. The steel is tapped from the furnace to the pouring ladle, cast into ingots and, after due heating in the soaking pits, is rolled down into blooms, billets and the particular finished shapes desired. The shapes, plates, etc., for bridge work are rolled entirely from basic open-hearth steel, three grades being produced, namely, "rivet," "soft" and "medium." Rivet steel has an ultimate strength of from 50,000 to 60,000 pounds; soft steel from 52,000 to 62,000 pounds; medium steel runs from 60,000 to 70,000 pounds. The elastic limit is about 50 per cent of the ultimate strength and test pieces of steel must be capable of being bent over on themselves to an angle of about 180 degrees without fracture.

Of late years bridge engineers have been calling for special grades of alloy steel, particularly for eye-bars, and in this case the ultimate strength will run up from about 80,000 pounds to 100,000 pounds per square inch with an elastic limit of 50,000 pounds.



Heavy plate girder for main line of New York Central near Depew, N. Y. Each of the two girders is 121 feet 6 inches long, 11 feet 5 inches high, and weighs 130 tons. The span is for double track

The visitor to any complete bridge manufacturing plant will be taken first to the stock yard in which the raw materials are assembled ready for the open-hearth furnace. Here he will find iron ore, scrapped steel, such as junk, crop ends, punchings and general scrap from the construction and machine shops. Also in some works he will find a considerable stock of pig iron in the stock yard. In other works, and those the most modern, the pig for the open-hearth furnace will be brought direct from the blast furnaces. Before the pig is run in, a certain proportion of cold scrap, etc., has been placed in the open-hearth furnace and the work of refining is carried on as described in Chapter VI, of the Story of Steel; SCIENTIFIC AMERICAN of June, 1924, page 396.

The blooms and slabs from which the shapes are rolled are themselves rolled down to size from ingots of suitable size. An 8 by 8-inch bloom will be rolled from an ingot about 20 inches square and a slab of, say, 7½ by 4¼ inches, will be rolled down from a 23 by 19-inch ingot. Generally, the ingots are rolled down into blooms in mills of the reversing type. The ingot, raised to the desired rolling heat in soaking pits, passes between the rolls, is received at the rear side, and, the rolls being then reversed, the ingot makes a return pass. What are known as pick-up fingers serve to turn the ingot over through 90 degrees if so desired between certain passes. After the ingot has been brought down by, say, from a dozen to fifteen passes, to a bloom of the required size, the bloom is transferred to a shear where it is cut into the length desired for rolling into the particular shape required.

The rolling of the shapes is frequently done on a continuous-type mill of eight consecutive stands of rolls. In a well appointed mill about one-half of the steel is rolled from the ingot to the finished shape without any intermediate reheating. The guide mills usually have six stands of rolls arranged consecutively in train. As a rule, the roughing and semi-finishing is done in sets of three-high rolls while the finishing is done between two-high rolls.

After having stated that the production of angles, I-beams, channels, etc., is done by passing the material between grooved rolls, it will suffice to direct the reader's attention to the two insert engravings showing the rolling of angles and I-beams. In the first pass, the opening between the rolls is large, but between each successive pass the rolls are brought closer together until in the final pass the opening or aperture has the exact cross-sectional area of the finished shape.

After the shapes have passed through the finishing mill, they are transferred by roller tables and brought to circular saws which cut them to the desired length. Similarly to the rails, the shapes, as finished, are usually out of alinement and have to be straightened before they are shipped to the customer. This straight-

ening is done in a gag press similar in its action to the straightening press described in our chapter on the manufacture of steel rails (see SCIENTIFIC AMERICAN, September, 1924, page 175).

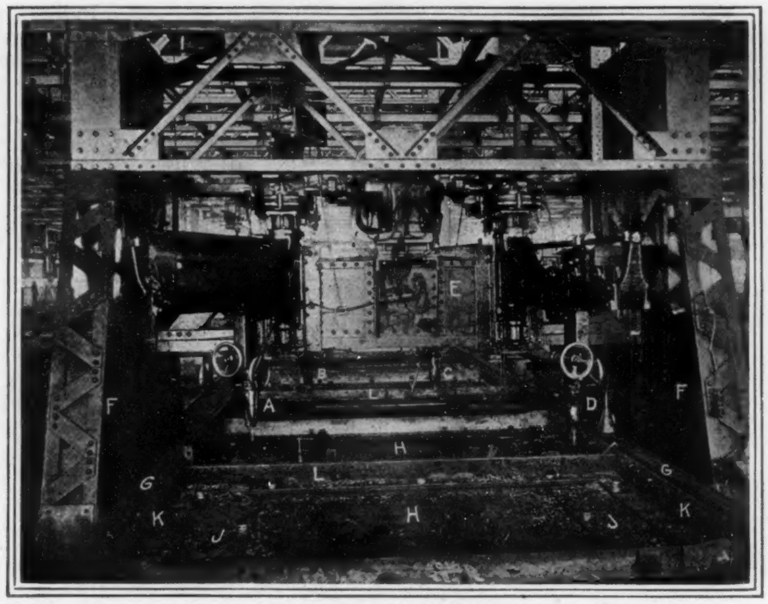
The art of bridge construction consists, so far as shop fabrication is concerned, in building up large and massive members out of a multitude of relatively small shapes as they are assembled in the stock yards of the bridge works. In the receiving yard at the Gary Bridge Works which is 285 feet in width and 800 feet in length there has been assembled, at times, in the way of plates, bars, angles, I-beams, etc., as high as 40,000 tons of material. Since in bridge building the weights run to high figures, it can be understood that the construction shops are so laid out as to render the operations as continuous as possible with a minimum of handling and transportation.

The first operation is to lay out the work by means of wooden templates in which the exact position of every rivet, angle, gusset, etc., is marked. As a matter of fact, the building up of the bridge material into those huge posts and tension members which look so awe-inspiring in a huge cantilever or suspension bridge, is a simple one, the chief requisite being great care and accuracy. The plates and shapes are sawn or sheared to exact length and, where it is called for, the sides and ends are planed and faced down. Holes for the larger pins are first punched and then bored to exact dimensions; but the small holes for bolts and rivets are punched by means of highly developed machinery driven by electric power. It should be mentioned, however, that there is a tendency to abolish the punching of rivet holes, because of the undesirable stress set up in the adjoining material, and substitute everywhere straight drilling.

The punching and drilling being completed, the separate pieces are assembled and bolted together, care being taken that the rivet holes are properly registered, reaming being resorted to, if necessary. The work is then riveted up by hydraulic and pneumatic riveters.

In the Gary bridge shops are assembled some of the largest and most up-to-date shearing, drilling and planing machines to be found anywhere in the world and one of our illustrations shows a multiple drilling machine of the gantry type at work upon a large plate girder. The drills A, B, C, D are carried on radial arms which are mounted on a transverse girder E which can be moved to and fro over the full length of the work which is being drilled. This transverse girder is attached at its ends to the two legs of the drilling gantry which travel on tracks running parallel with the work. Incidentally, this picture illustrates admirably the way in which the plates, angles, etc., are assembled and riveted up to form a plate girder bridge. Thus, against the gantry legs are seen the upper and lower chords G, G of the bridge, and each chord, at its center where the stress is greatest, is built up of five superimposed plates. Between these chords is the web H, H of the girder which consists of a single plate. At the chords the web is reinforced first by wide, flat plates J, J and then by angles K, K which are riveted both to the web and to the assembled chord plates, the rivets passing right through the whole of the assembled material. The pair of angles L, L placed back to back which extend between the chords serve as stiffeners to prevent deformation of the web. It will readily be understood that the rapidity with which the drills can be swung into any desired position, greatly facilitates the rapid execution of the work.

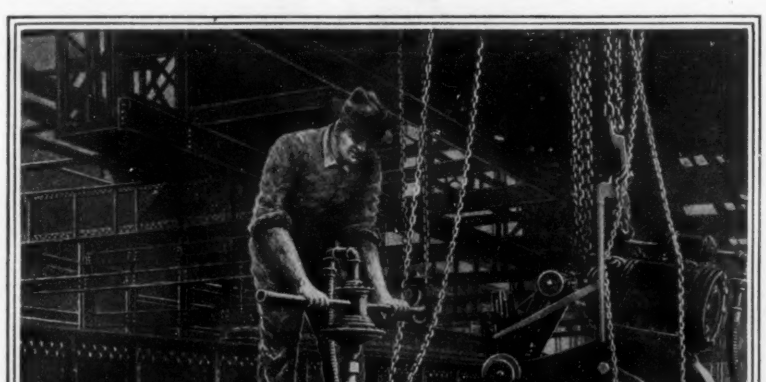
Another of our drawings shows the riveting up, in another large bridge works, of a 35-ton chord section for a bridge of large dimensions. This drawing shows two tools which have done great service in bridge construction; namely, to the left an electrically driven portable drill and just beyond it a portable pneumatic riveter. Of late years there has been a great development in the size and power of bridge building tools and in the Gary shops there are hydraulic riveters capable of exerting a pressure of 100 tons on a hot rivet head.



Drilling a massive plate girder in a gantry drilling machine. The girder, lying on its side, consists of a web, H, H; upper and lower chords G, G; re-enforcing plates J, J and angles K, K; and web stiffening angles L, L. The four drills A, B, C, D, are carried in radial arms, attached to girder E, which is mounted on the legs F, F of the machine

After the bridge members have been completed at the shops they are shipped out to the site where the bridge is to be erected; and it can readily be understood that the speed with which the erection proceeds depends very much upon the extreme accuracy with which the work has been done in the fabricating shops which may be located several hundreds or thousands of miles away from the bridge site.

Twenty-five or thirty years ago, American bridges of 500-foot span and less were almost universally of what is known as the eye-bar type; that is to say, while the compression members were of built-up box or rectangular cross-section, the tension members almost invariably consisted of eye-bars; that is flat bars provided with an eye at each end for engagement with a common pin. The eye-bar type provided a bridge that was easy and quick in fabrication and lent itself to rapid erection.



Drilling, reaming and riveting up a 35-ton chord section for a large bridge

In those days, moreover, even in bridges of 100-foot span and less the open triangulated truss bridge was preferred. Of late years, however, there has been a marked tendency towards riveted plate bridges in which even the tension members are built up from assembled plates and shapes. The field of the plate girder which formerly was restricted to very short spans, has been extended until today we find that 100-foot span plate girders are common and not a few of this type have exceeded 100 feet. The longest plate steel girder built at the Gary works measured 115 feet 6 inches. This type has found its most extensive use among the railroads.

Methods of Evolution

PROFESSOR J. E. DUERDEN of Rhodes University College, South Africa, has an interesting discussion, in *Science Progress* for April, 1924, of the methods of evolution. Professor Duerden questions the orthodox view of evolution by gradual transformation. Mendelism, he says, involving as it does the distinctness of the characteristics of an organism and the conception of discrete germinal factors, is one of those fundamental principles which insistently confront us when we try to interpret zoological phenomena. We are so accustomed to think in terms of gradual transformation that it is with some reluctance we turn to discontinuity. The whole of our comparative morphology and homology is founded upon gradual transformation, yet if we are to accept Mendelian teachings this is not the manner in which the change from one form to another has occurred; rather, each modification is discrete and discontinuous in its nature, and apart from those which have gone before and from those which may follow.

In support of his contention, Professor Duerden uses his studies of the ostrich. The ostrich, he says, is unique among living birds in that it has but two toes, a large inner and a small outer. On the theory of gradual transformation we should assume that this condition has slowly evolved through successive stages from a four- or even a five-toed ancestor, and is possibly transitory to still further retrogression. We have, however, unmistakable palaeontological evidence against any evolutionary change in the toes of the ostrich within a comparatively recent geological period. If no alteration has taken place in these structures during these tens of thousands of years, we may well be assured that they have been fixed characteristics of the bird since the time when they first assumed their present relative proportions. Functional adaptability is probably not concerned; for, if it be held that the one-toed condition of the horse is advantageous for rapid progression, would not a broad, padded, single toe be more serviceable also for the ostrich? But the two toes seem as well fixed in their present relative proportions as is any other feature of the bird. There appears, therefore, to be a discreteness, a completion, about the evolutionary stage in the foot of the ostrich which would hardly be expected of a condition which has been attained as a result of gradual, continuous transformation. In conclusion Professor Duerden says: "If we accept the Mendelian interpretation of separate and independent factorial changes in the ancestral germ plasm for a living transitional series, are we not impelled to do the same for all the striking transitional series which palaeontology affords, and which are deemed to be the best illustrations we possess of continuous orthogenetic evolution?" "May not doubt even be cast upon the accepted phylogeny, say, of the horse, as interpreted from palaeontological records?" "Mendelism seems to impel us to think of the many known transitional graded series of both extinct and living forms as having arisen apart and independently, much after the manner which Morgan has shown to be the case with regard to the graded series of wings, body colors and eye colors procurable among the mutants of Drosophila."

The Gasoline-Electric Bus

THE gasoline-electric bus is driven by a gasoline engine as is any other bus; but, in addition, it carries a 42-cell storage battery, two driving motors and an electric generator direct connected to the gasoline motor.

Why carry all this extra weight; why go to the trouble of installing all these extra power units; and why spend the extra money they cost? It is obvious, of course, that the gasoline engine drives the generator, that the current generated is passed to the motors which drive the rear wheels; and that the storage batteries are floated on the line as a sort of "flywheel" for the absorption of power generated in excess of current need and for passing this stored power out to the driving motors in times of heavy power demand.

This bus was developed by Prof. Morton Arendt of the Department of Electrical Engineering, Columbia University, and W. Brown Morton, New York City, and has been in regular service for several months.

Instead of shifting the usual gears and throwing in a clutch, the driver turns the handle of an ordinary trolley-car controller situated just at his left. There are seven running points on this controller, corresponding to seven speeds. The get-away is very rapid, from standing to 15 miles per hour requiring but seven seconds.

The gasoline-electric bus is by no means a freak or "stunt" creation. It was not designed to attract attention or to tickle the vanity of those who love mechanical complication. Every feature contained in the bus has not merely an excuse, but a very good mechanical and economic reason for being included in the design.

First, a high fuel economy is made possible by reason of the use of an extremely small engine run with an open throttle as long as the vehicle is under way. In other words the operation of the power plant, instead of being intermittent, is constant. Since the storage batteries are always ready to absorb excess power and give it back to help drive the vehicle when the power plant is not large enough as is the case when accelerating or climbing a hill it is unnecessary to carry around a motor of capacity based on the extreme or maximum demand for power. The engine develops but 20 horsepower at 1200 r.p.m.

Second, the clutch and gear shift which in general practice represent high maintenance features are eliminated.

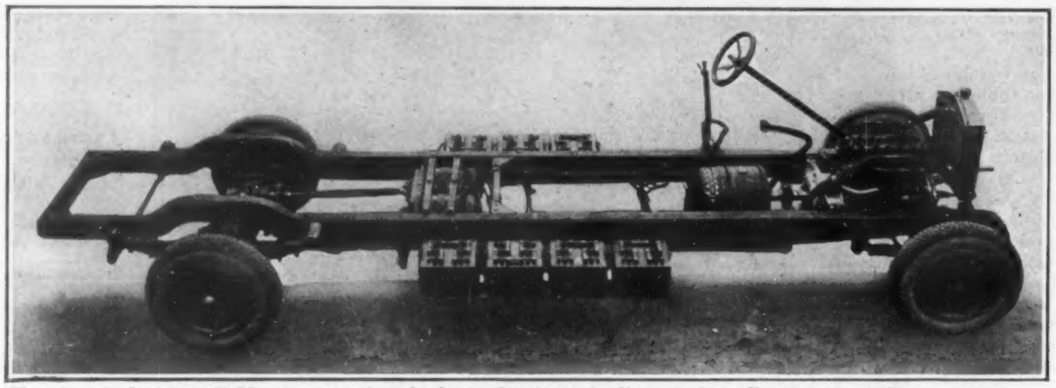
Third, the double drive clearly shown in one of the illustrations entirely eliminates the expensive and often troublesome differential.

Fourth, in the ordinary gasoline vehicle rapid acceleration which is extremely important in traffic is limited by the top power of the engine and the necessity of losing time by shifting gears.

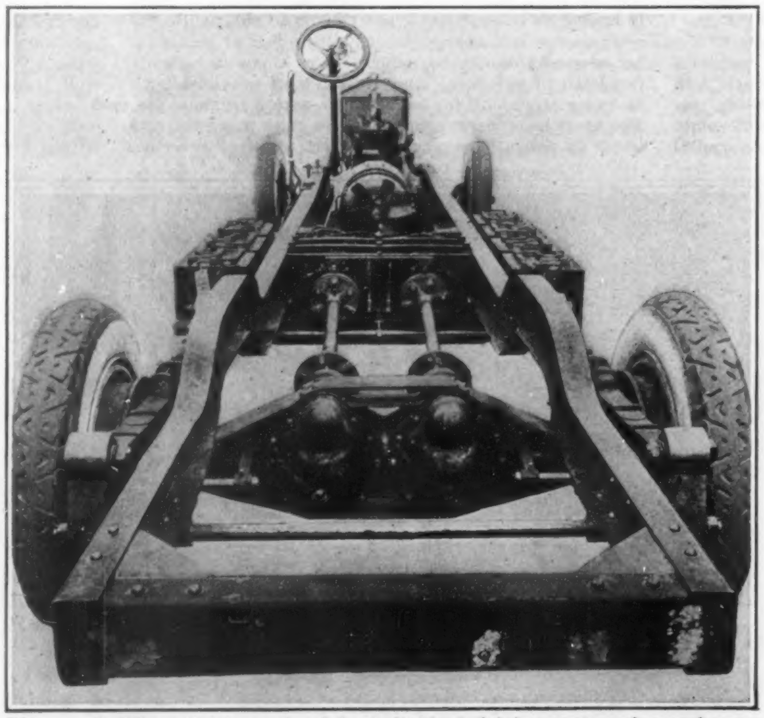
The storage battery is not intended to drive the vehicle without help from the power generating unit, but it is capable of driving the vehicle, weighing 10,200 pounds, a distance of five miles. This is enough to enable the vehicle to get back to the garage in most cases when any serious trouble incapacitates the engine, or if the gasoline runs out. The batteries are controlled automatically so that they may charge or discharge as occasion demands. In addition, an automatic device cuts the engine speed from 1200 r.p.m. to 900 r.p.m. when the vehicle is coasting or standing still. The purpose of this is to prevent an overcharge of the storage batteries. The generator develops 120 amperes at 100 volts, while the two propulsion motors are rated at $6\frac{1}{2}$ horsepower each.

This bus has operated in all about 10,000 miles, partly in cross-country work near Philadelphia and 3000 miles on the 96th Street run in New York, an extremely severe run due to the heavy traffic in rush hours, the number of stops per mile, and the grades encountered. During this time there has been, according to Professor Arendt, no expense whatsoever in the maintenance of the electric equipment, except such as sandpapering some of the contacts and watering of the batteries.

The engine has four cylinders, each measuring $3\frac{5}{8}$ by $5\frac{1}{8}$ inches while ordinary "gas" buses of equivalent carrying capacity (that is, 25 passengers) employ four-cylinder engines of about $4\frac{1}{2}$ by 6 inches size, or nearly twice this size. The gasoline consumption ranges from seven to nine miles per gallon, and a speed, on the level, of 30 to 35 miles per hour is obtained, the lowest speed being 11 miles per hour. For still lower speeds the driver moves the controller handle back and forth from neutral to first point, as do trolley-car motormen.



Chassis of the Arendt-Morton gas-electric bus, showing gasoline engine, direct-connected generator, two driving motors, and storage batteries which act as a power "fly-wheel"



The usual differential is replaced by individual driving motors for each rear wheel, connected to the wheels by separate propeller shafts and worm reductions

Unification of Australian Railways

THE Government of Australia has a plan for unifying the several state railways of that land. Owing to the fact that when the Commonwealth's railways were first built there was a strong sectional feeling which prevented the growth of a standard-gage system, it will be necessary to alter most of the rolling stock, as well as to change the five-foot three-inch gage of the state of Victoria, and the three-foot six-inch gage of a part of the railways of South Australia to a standard of four feet, eight and one-half inches. Heretofore it has been necessary to break cargoes on the transcontinental railway route on entering the several states. The unification plan further includes a project for a north-and-south transcontinental line from Adelaide to Port Darwin in the North. Two short spurs of this line are already in use, and it is these which are to be extended. The plans do not, however, involve bringing their ends entirely together as yet, as it is not felt that economic conditions warrant the expenditure.

Pulling the Teeth of a Dangerous Machine

WE recently interviewed a member of a firm having several hundred punch presses in their plant in Milwaukee; in five years the plant was raised from the unenviable position of having the worst accident rate to the best. This was accomplished by making the machine accident proof particularly at the "point of operation." The punch press has always been one of the most dangerous tools ever devised.

In a report published by the Industrial Commission of Wisconsin covering all compensable injuries in 1920, punch-press accidents stood fourth on the list in point of numbers, but first on the list in regard to the total permanent partial disabilities, this cause of accidents resulting in the permanent maiming of more than twice as many men as any other single kind of accident. They caused a loss of 92,778 days which was 44,220 more days than was due to any other type of accident. These accidents cost in compensation and medical attention $67,163, which was 26 per cent greater than the cost of any other class of accidents. From the foregoing figures it will be seen that in point of severity of injury, lost time and compensation cost, punch press accidents are the most costly of all.

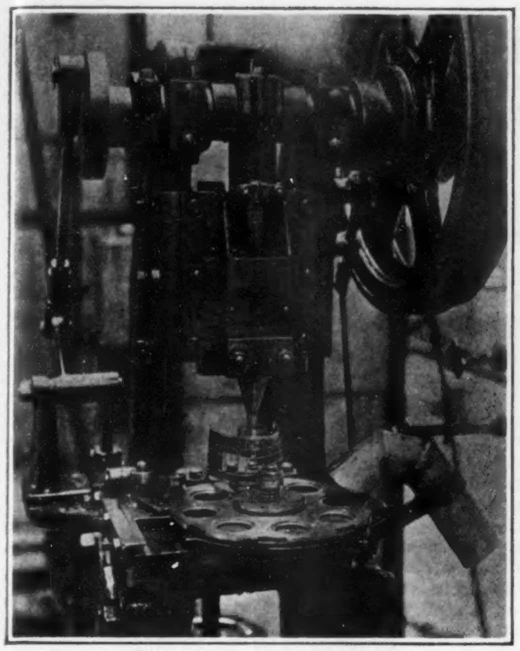
The American Engineering Standards Committee has formulated a code of 52 pages in which 20 societies are listed as sponsors. Every detail is taken up where there is the slightest opportunity for accident. The hazards are too numerous to list here.

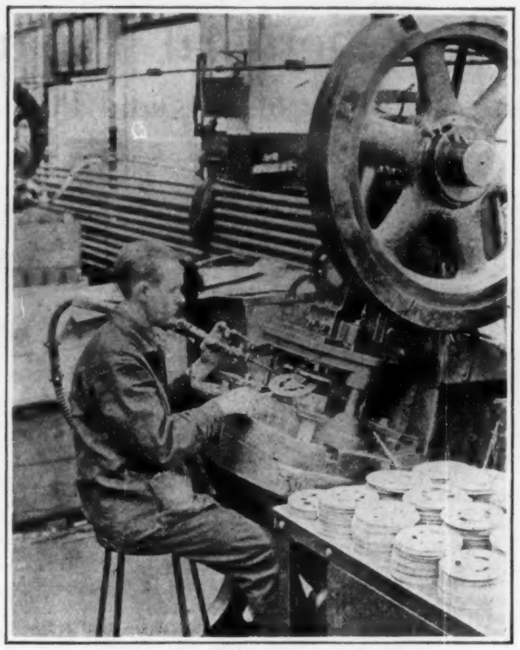
The most generally successful methods of safe press operation are those in which the material is placed and removed without the operator's hand being put under the ram at any time. They eliminate all the hazards and prevent accidents caused by inattention or other failure of the operator as well as those caused by mechanical defects. These methods also generally result in an increase in production and a decrease of spoilage. One or another of them should therefore be used wherever possible.

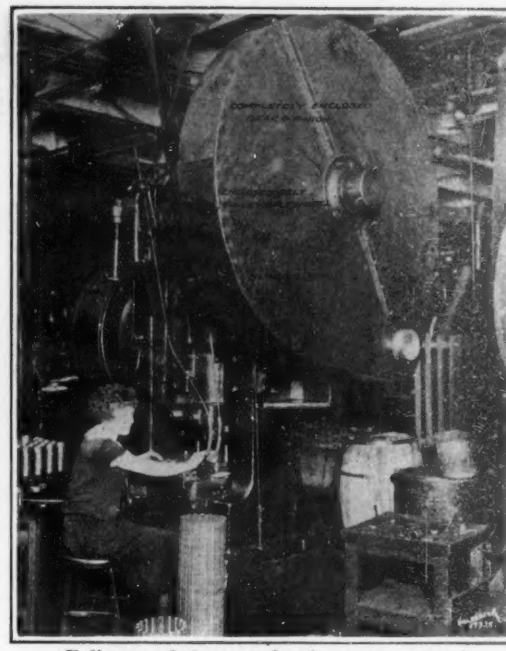
The automatic and semi-automatic feeds have increased production and have eliminated almost entirely the possibility of accident. They may be classified as follows: push or pull automatic feeds; plunger feeds, chute feeds; revolving, or dial feeds; sliding dies, sliding feeds, and safety feeding springs.

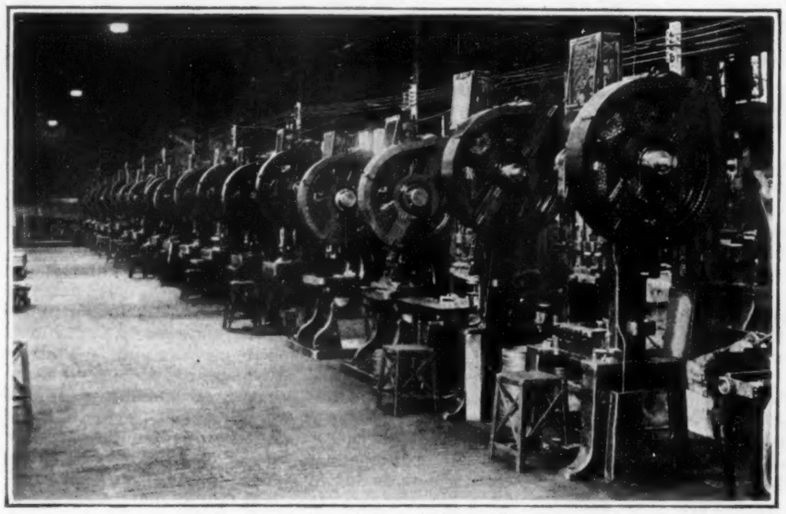
Enclosing guards are of great importance and are of many different types. For most hand-set blanking work, and for some forming operations, complete protection can be provided by an enclosing guard with space between guard and lower die sufficient to admit stock but not fingers —not exceeding three-eighths inch. Such guard is often attached to the stripper. To permit a view of the work the guard or the front portion of it is often made of wire mesh, wired glass, or mica. The guard may be in telescopic form or in the form of a spring. As such guards must fit the size and shape of the die, it is essential that the die-maker or die-setter be made responsible for procuring and setting up a proper guard for each new operation. One large user of such guards carries them in standard sizes; the opening, through which the upper die passes, varying at one-inch intervals. For complete protection the guards should enclose the rear as well as the front and sides of the ram, or the lower die should be extended by means of a horizontal plate so as to prevent reaching in from the sides or rear.

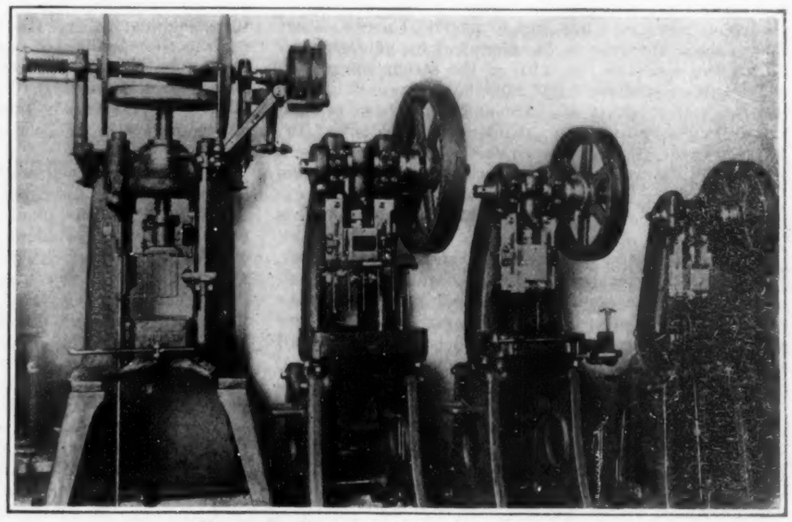
Hand tools for feeding have been developed and are used successfully on operations where automatic feeds or enclosing guards are impractical. Pneumatic devices have also been used successfully. "Two hand" operating attachments are valuable and are very safe if the workman does not "rig" the mechanism which is sometimes done. Non-repeat and treadle disconnecting attachments round out the list.

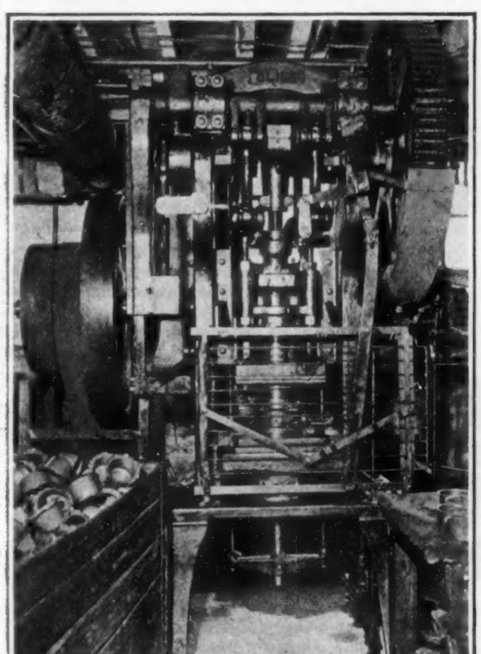

Dial feed speeds production

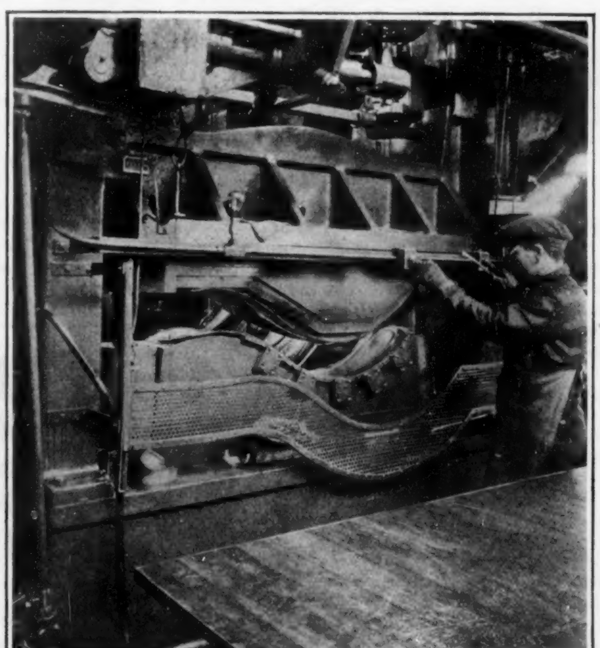

A safe way of feeding punch presses

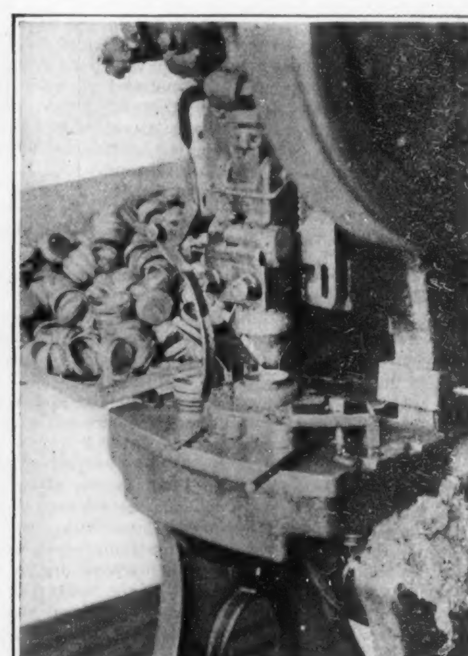

Fully guarded press showing sweep guard


A battery of well guarded punch presses


One manufacturer guards in many ways


Sweep gate guard for toggle drawing presses


Guard for fender die rises and lowers with press stroke


Chute feed speeds production

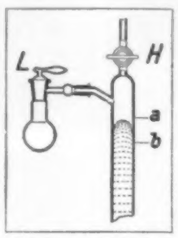
THE PUNCH PRESS, THE WORLD'S MOST DANGEROUS TOOL, AND HOW IT IS ROBBED OF ITS MENACE IN THE UP-TO-DATE FACTORY

Charcoal, the Chemical Truant Officer

A New Process for Catching Volatile Solvents and Putting Them Back to Work

By Ismar Ginsberg

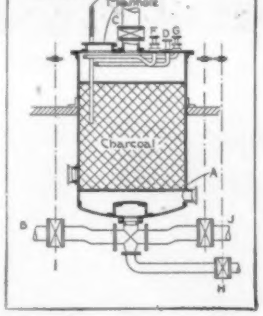
IN THE reaction chambers or drying rooms where such products as coated fabrics, artificial leather and fatty extracts are being treated—to name a few only of many—it is present practice to permit a large volume of volatile solvents to go to waste. Especially in the artificial leather factory, quantities of these solvents, which could be used over and over again if they could but be recovered, are lost through evaporation. True, chemical means are available for recapturing the alcohol, ether, benzine and what-not in question; but the installation of plants for this purpose is so extremely expensive that many a manufacturer hesitates to go to the expense of putting up such a plant.



Showing drop in vapor pressure

Under the auspices of Bayer and Co., one of the large German chemical trusts, a new process has been introduced for the recovery of these solvents. In its fundamentals it is simple enough. We all know that a pan of charcoal-dust placed in a refrigerator will absorb the odors that may be evolved therein, and which might otherwise spoil the butter and other food stored in the ice-box. This property of absorbing gases was first put to practical use on other than a domestic scale in the manufacture of gas-masks during the war; but in spite of the strong suggestion which this application might have been expected to give, this familiar property of charcoal has not been utilized to any extent industrially. Under the direction of Dr. A. Englehardt, the well-known chemist, it has now been applied in the recovery of volatile solvents, and has reached a stage of development where the hope is extended that it will furnish a final solution of this problem.

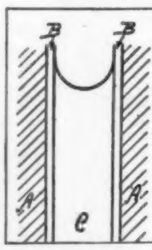
In the industries where alcohol and its derivatives, ether and acetic ester, are used, as well as those employing benzol, acetone, benzine and numerous other volatile solvents, attention has been directed of late not alone to the securing of substitute solvents which shall give the same results and which at the same time shall be less costly, but also to the recovery of these solvents from the waste gases evolved in the various processes in which they are used. The old methods of recovery consist either in cooling the gases under pressure, causing thereby a precipitation of the vapors; or in washing the mixed vapors and air with carbon absorbents, which either have a purely physical solvent action on the vapors, when high-boiling oils and alcohols are used, or else a chemical action, in the case where sulfuric acid, cresols, etc., are used. In the first process a considerable amount of energy is consumed in the operation, and the installations of apparatus are very large and expensive. Consequently they can be employed only where the waste gases contain high concentrations of the solvent vapors. In the second process, most of the absorbents used have very little absorbing power, and after they have performed their function they must be regenerated before they can be reused. Only sulfuric acid, which is used in the absorption of alcohol and ether, and the heavy oils, which are used to wash out the benzol contained in coke-oven and illuminating gas, have assumed any industrial importance.



The absorption apparatus

In both the last-named processes large and costly apparatus is necessary and in the case where sulfuric acid is used the apparatus must also be covered with a coat of lead in order to protect it from the corrosive action of the acid. Then again inasmuch as the absorbents must be recovered themselves, a large consumption of steam is entailed, and in order to reduce this consumption and the cost of the operation it is necessary to install complicated and expensive heat-exchanging and conserving apparatus. The cost of the operation and upkeep of the apparatus and the amortization expense of the same are so high that it just about pays to attempt to conduct a solvent recovery plant in this manner under certain conditions, and consequently the process is used only where the volume of gas treated is very large. It is for this reason that the process has not been installed in the smaller industries, as, for example, in the artificial leather industry, where, while a large amount of solvent is lost in the drying of the leather, nevertheless no attempt is made to recover it. The cost of running the process was found to be greater than the value of the recovered solvent.

The main disadvantage of all these processes, however, is that not one of them recovers the vapors from the waste gases without leaving a part of them behind. If an attempt is made to conduct the process so that the solvent recovery is 100 per cent, then it is found that the number of scrubbing towers is so large that it becomes absolutely impractical to operate in this fashion. For example, even at low temperatures a trace of benzol in the heavy oils that are employed in the recovery process will be sufficient to cause a vapor pressure in the absorbent liquid so high that the benzol vapor will be in equilibrium with the benzol in the absorbent oils; in other words, no more benzol could be removed from the waste gases under these conditions. This forms the practical limit to which the process can be pushed, and any gas which contains less than that concentration of benzol can not be treated. It also means that the gases leaving the absorption apparatus will always contain that amount of benzol which will be absolutely lost. When the concentration of benzol in the gases that are being worked with is not very great, then this loss may be determinative in the economic success of the process.

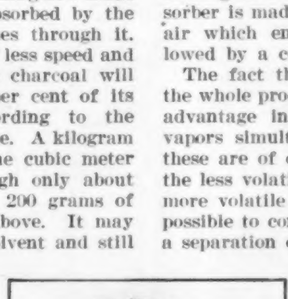


The capillary meniscus

In the last few years a carbon absorption process has been invented and perfected in the Bayer dyestuffs plant at Cologne. This process recovers completely volatile solvents of all sorts from gases which contain them in even the smallest concentrations.

The charcoal is used in the form of very light and fine particles about the size of barley grains. The object of making the charcoal in this form is to take advantage both of the condensing power of the surface of the charcoal as well as of the absorptive capacity of the material. Charcoal in this form will absorb about 20 per cent of its weight in ether, alcohol, acetone, benzine and benzol, when the flow of gas is about 20 centimeters per second. This applies to the concentrations of these solvents usually found in technical waste gases. The rapidity of the flow of the gas and the degree of concentration are two important factors in determining how much of the solvent will be absorbed by the charcoal as the gas passes through it. Under better conditions of less speed and greater concentration the charcoal will absorb from 60 to 100 per cent of its weight in solvent, according to the specific gravity of the same. A kilogram of the charcoal—about one cubic meter of the material will weigh only about 250 grams—will take up 200 grams of benzol under the conditions described above. It may be saturated with half a liter of any solvent and still feel perfectly dry to the touch.

The bond that is formed between the solvent and the absorbent is a very fast one, but the solvent may be recovered by heating the carbon to a temperature over 200 degrees Centigrade without the use of a vacuum. Because of the poor heat conductivity of the carbon this method is not very efficient. The solvent may be recovered from the absorbent very readily by blowing a current of steam through it. The steam is introduced at the top and passes through the powdered mass, leaving the apparatus at the bottom. At the start of the process vapors of the pure solvent are obtained and then a mixture of the solvent vapor and steam. Both steam and solvent vapors are condensed in the ordinary type of condenser, and if the solvent is insoluble in the water, separation is effected by the use of a separatory tank, while if the two liquids are soluble in each other, distillation must be resorted to.



Particle of absorptive charcoal under the ultramicroscope

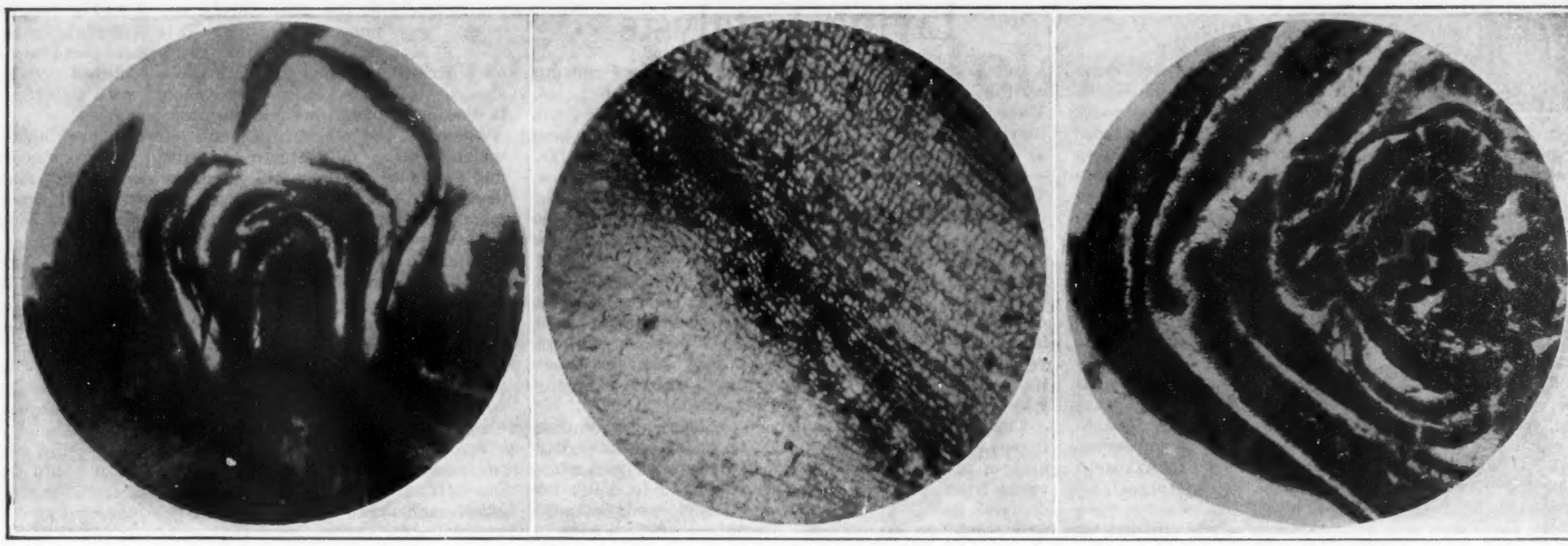
Under the microscope the charcoal has the structural form indicated in our final diagram. *A* represents minute particles, a few millimicrons in size, separated by a system of capillary spaces *B* which form from 40 to 80 per cent of the mass. The initial process of absorption consists in the wetting of the inner surfaces; and when we reflect that a one-centimeter cube of this structure has an inner surface of some 6000 square meters against six square centimeters for a solid cube of the same size, we can appreciate why the process goes so far. The film that wets these surfaces, however, grows in thickness rapidly; and as soon as it surpasses a thickness of some .0000001 millimeter, corresponding to the radius of molecular action, the entire space between the charcoal particles begins to fill by capillary action, as indicated in our third drawing. *A* is here the charcoal frame, *B* the absorbed film, and *C* the further fluid drawn in by capillary force. On the surface of this fluid a meniscus is formed, whose pull causes the reduction in vapor pressure observed during the absorption process. Our first diagram is of an apparatus for demonstrating this. The air is completely exhausted and a little ether admitted through the valve *H*. The mercury in the column sinks a distance equivalent to the vapor pressure of this. The cock *L* is opened and the charcoal in the bottle beneath it quickly absorbs the ether vapor, whereupon the mercury rises from *b* to *a*.

The apparatus used is cylindrical, with a cross-sectional area of several square meters. The charcoal rests on a perforated plate *A*, and extends to a height of about one meter. The air charged with vapors enters at the bottom through the pipe *B*, passes through the bed of charcoal, and escapes through the outlet *C*, a fan accelerating its passage. These absorbers are arranged in series, so that as soon as the material in one is saturated the vapor-air mixture may be shunted to another charge with fresh absorbent.

Steam is blown into the saturated absorber through the opening *D*, and passes through a perforated coil which sprays it equally over the absorbent mass. The vessel is heat-insulated, and an auxiliary coil through which steam is blown continually keeps the working steam hot enough so that it is not precipitated in liquid form on the surface of the charcoal. The steam carrying the solvent vapors from the charcoal leaves through the outlet *H* and is conducted directly to a condensing coil. Decantation or distillation is the next step, according to the circumstances. The charcoal in the absorber is made ready for use again by a current of hot air which enters at *J* and dries it thoroughly, followed by a cold air-blast to cool it off.

The fact that charcoal is chemically neutral makes the whole process of peculiar value. It has a particular advantage in its ability to absorb several different vapors simultaneously from the same vehicle. When these are of considerable variant degrees of volatility, the less volatile ones will drive out of the charcoal the more volatile ones which it first takes up. It is then possible to connect up a series of absorbers and obtain a separation of the absorbed vapors according to their volatility.

The cost of the apparatus is comparatively low. An ordinary cast-iron vessel may be used for the absorber, with such protection as the nature of the absorbed vapors or their vehicle may necessitate. The space taken up is small. The steam consumption is about eight times the weight of the recovered solvent. Superheated steam effects an economy; in fact, steam at 180 degrees Centigrade is not absorbed by the charcoal at all, and it is not necessary to follow the use of such steam with a drying of the charcoal. Labor costs and wear and tear are low. The charcoal has an effective life, it appears, of at least several years. When the apparatus is not running, it requires no attention of any sort. The cycle of operation covers eight to ten hours.



Left: Longitudinal section of flower bud of sassafras. *Center:* The light line between the two dark lines shows cork cells which cut through the veins of the petiole in the fall, causing the leaf to die. *Right:* Maple bud, showing arrangement of leaves and flowers

What happens when the leaves begin to fall, as shown by microscopic studies of the cross-section of leaf, stem and bud

When the Leaves Begin to Fall

By Dr. Ernest Bade

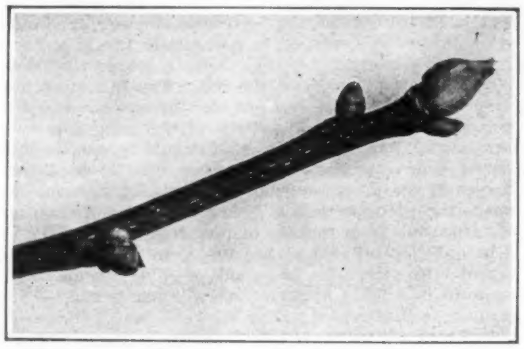
SUMMER has come and gone. The fields, covered with goldenrod, are bright with the long spikes or flat heads of these harbingers of autumn. The brush, edging the cultivated farms and carpeting the hillsides, is slowly beginning to turn a sickly yellowish brown, appearing as dirty spots among the bright green foliage. Soon autumn will have made its colorful entrance, and the gay-hued leaves will be holding off the approaching winter with their fiery coloration.

Just as the foliage of the various trees and shrubs does not appear at the same time in the spring, so the leaves die at different periods in the fall. Maple, beech and hickory let their leaves drop when the frost has touched them and the first cold autumn storms have shaken them. But the winter oak holds tightly to its dead leaves, like the miser to his gold. In fact, some of these leaves will still be on the twigs in the spring, when the new shoots make their appearance. On the other hand, the foliage is stripped from the white birch by the cool winds of early autumn, and the walnut leaves barely survive the summer.

The time of leaf-fall may be hastened or delayed—all depends upon the weather. But before the leaf detaches itself and drops to the ground, it invariably assumes its festive garb. And the dark brown coloration of the heather is produced by the same material that is in the red beech; in both cases this tinting is an attempt at protection against the strong intensive rays of the autumn afternoon sun, as contrasted to the chill of morning and night.

The change of color is most readily observed in the heather, that part being more strongly painted which is most exposed to the sun. The light yellow and orange colored tints are produced by a different coloring material. It is the same substance which makes the carrot yellow. The purple color of the beet leaf corresponds, in its derivation, to the color found in *Cheiranthus annus.*

Many of the colors found on the foliage in the autumn do not arise during this season, but become visible only at this time after the green coloring matter, the chlorophyll, has disappeared. In the fall, when the vitality of the plant is reduced, a migration of those substances in the leaf takes place, which may be of use at a future time, and these are stored in the twigs. The products left in the leaf, producing as they do the autumn coloration, are of no further use to the plant, in fact it is of great advantage to be rid of such waste substances so easily. Nothing is suddenly produced when the leaves begin to fall, which has not already been formed; nothing occurs which is not followed by essential results. The cause is not found in the universal cycle of life in which generation, being, and decay are bound together like the links of a chain so that life comes from death, and death from life, neither does the leaf follow the mighty downward pull of mother earth in order to give back that which was taken from her. These are not the causes, they are the results. Tree and shrub have prepared themselves for months for the coming loss in leaves, they themselves have produced, by a certain formation which is slowly taking place within the plant, a partition, which gradually shuts off the leaf from the mother plant, thus dooming the leaf to a slow and lingering death.



The scars left on the twig by the falling leaves

The falling of the leaves is caused by the diminution and the final stopping of the flow of sap to the leaves. The wilting, the changing to a black, brown, yellow, and red is not caused by freezing but by a drying out. Frost only occurs after the last winter asters have withered away, and at this time all trees and shrubs are bare, lifting their leafless twigs and branches into the cold late autumn air. The dry foliage rustles under the feet of the wanderer, the fitful winds playfully toss the dead leaves high into the air, now building a mound in some hollow and then again carrying them helter skelter to some other, more distant place.

Quercus alba, the familiar white oak, after the autumnal change

The Physics of Snow

ADIABATIC cooling; *i. e.,* cooling without either gain or loss of heat energy, plays no part in the formation of mists and fogs, because the pressure changes in any given layer of the atmosphere are always relatively small and slow. Appreciable adiabatic cooling can take place only when air is raised in the atmosphere, with a consequent change of pressure, and then the cooling may be large and rapid. When air not saturated rises in the atmosphere its temperature is reduced by about one degree Centigrade for every 100 meters of ascent. When the ascent is carried far enough the dew point is reached, after which any further rise will cause condensation on the nuclei present. As the ascent is carried beyond the point of condensation more and more water is deposited, with a consequent increase in the size of the drops. This is the manner in which clouds are formed, and there are very good reasons for saying that it is the only way.

Snow forms over an ascending air current in which there are solidified cloud particles for nuclei. But, whatever the nuclei may be, as soon as the initial crystals are formed, further condensation takes place, the vapor condensing directly into the solid state without first going through the liquid state. The crystals of water are hexagonal prisms, and water in the crystalline state in the atmosphere shows all the wonderful shapes that this form of crystallization can take. Having once started, the crystals may grow either along their central axis, giving rise to long thin prisms, or along their six axes to form hexagonal plates. Sometimes the growth is uniform, so that the result is a perfect hexagonal plate, at others the growth along the axes is more rapid than in the space between; this gives rise to star-shaped crystals, having a beautiful feathery appearance.

The actual crystals vary in size, from minute crystals which can scarcely be seen by the naked eye to plates a quarter of an inch in diameter. In cold regions the crystals are small, because there is little water vapor present from which they can grow. In the Antarctic during the winter only the smallest crystals are seen, so small that they are almost like dust. When crystals form at temperature near the freezing point they grow to their largest size. When the air is full of large crystals frequent collisions take place. The crystals become interlocked and bundles of many separate crystals are formed; these produce the ordinary snowflakes which, on account of their size and weight, fall relatively rapidly. It is to these latter that the term snow should be applied. With this restriction, snow occurs only when the temperature is near the freezing point.

Living Catalysts

CHEMICALS react. Chemical action thus takes place with the formation of new substances that possess altogether different properties than the original materials. Not only do chemicals react but they react at a certain speed and with a certain degree of ease. In chemistry, moreover, there are certain substances which by their very presence cause chemical reaction to take place or to increase in rapidity, and these very substances are not changed during the course of the process. At the end of the reaction they are present in the same form as at the beginning. They undergo no change, although their potency is gradually destroyed, the longer they are used; they are "poisoned," as the saying goes. These substances are known as catalysts and their action is called catalysis.

A small amount of a catalyst will cause comparatively enormous amounts of substances to react with one another. Thus, four ten thousandths of a gram of platinum will cause the union of some ten quarts of oxygen and hydrogen. Catalysis plays an important part in industry. The manufacture of sulfuric acid from the elements is made possible by platinum and other metallic catalysts, the manufacture of a fat from an oil, as in the case of cottonseed oil, is effected by means of a nickel catalyst, the production of nitrates from the air is a catalytic process. There are many others.

An enzyme is a living catalyst. In other words it is a living organism that possesses the power of causing certain important chemical reactions to take place. These are not only of prime industrial significance, but they are responsible for the changes that take place in the human body, the digestion of food in particular.

The enzymes are extremely interesting substances. They are most potent reagents or rather catalysts. Just to illustrate what power they possess, it is said that one drop of a dilute solution of rennet, which is an enzyme, is able to coagulate or transform four hundred thousand times its weight of casein, a process which is used in the manufacture of industrial casein and casein products. Similarly one part of invertase, which is an enzyme that is obtained from and is contained in yeast, is able to convert two hundred thousand times its weight of sucrose, ordinary sugar, into invert sugar which is quite a different substance.

There are quite a few enzymes. Among the most important is the enzyme diastase. There are in reality quite a few varieties of diastase. One such variety is made from barley malt. This enzyme has many industrial uses. It possesses the power to decompose and solubilize starch and the intermediate products obtained by the decomposition of starch, such as dextrin. Thus in the process of printing calico, before the cloth can be treated, and just after the loose threads and fuzz have been removed by singeing, the size added to the fiber during the spinning process must be removed. This is done by soaking the cloth in a diastase preparation over night. The next morning the solubilized starchy size can be easily removed by washing with water. It is also used in various fermentation processes.

Some of the other important enzymes are lactase which acts on milk sugar converting it into glucose and galactose, maltase which acts on dextrin and malt sugar converting it into glucose, steapsin and lipase which convert fatty substances into glycerin and fatty acids, pepsin and trypsin which change meat and protein substances into proteins of lesser complexity, such as proteoses, peptones, etc., and finally amino acids. Oxidin is an enzyme which oxidizes the coloring matter in cereals and maltase is the corresponding enzyme that oxidizes the coloring matter in fruits.

Maltase is used industrially in the manufacture of glucose, in the manufacture of Japanese yeast, and the beer known as saké. Zymase or alcoholic diastase is used in brewing beer, decomposing sugar to alcohol.

It should be pointed out here that most of the enzymes are found in the juices that are fed into the digestive tract of the human system from various glands and organs that constitute the digestive system of the body. The enzymes are the active agents in the digestion of food, commencing with the enzyme ptylin in the saliva, which has the effect of partially digesting starchy foods and going through the pepsin in the gastric juice, the trypsin in the intestinal juice, etc.

The Whys of Paper and Ink

PAPER is made from cellulosic fiber. The original raw materials are subjected to treatment with chemical agents, and in some case mechanical means are also applied, either alone or in combination with chemical means. This results in the removal of the large amounts of extraneous matters that are usually found in intimate admixture with the cellulose in the raw materials employed for the manufacture of paper. In this respect reference is had particularly to the raw material wood, which is the chief source of supply of the pulp from which most papers are made. Rags, old bagging, hemp ropes, straw of all kinds and waste cellulosic materials, such as sugar-cane bagasse, rice stalks, etc., are also used in some quantity, but by far the greatest proportion of paper is made from wood.

Treatment removes, as has been said, the greater part of all extraneous substances and leaves behind the comparatively pure cellulose fiber. This fiber may be made into a paper without further treatment, but if this is done a very poor grade of product is obtained. If the sizing treatment or a greater part of it is eliminated, then a paper is obtained which will not hold ink. Newsprint is one type of such a paper, while blotting paper is another. There is a marked difference, however, between the two.

Newsprint, which is the cheapest form of paper, is purposely made unsized for reasons of economy. Size costs money and it is not desirable to incorporate any of it in the paper pulp to make such a cheap product as newsprint. Furthermore no real advantage would be gained by its use for this purpose.

Blotting paper is also intentionally made unsized, but here the conditions are different. The paper must be made with considerable care and only certain kinds of wood can be employed in its manufacture.

Writing paper on the other hand is purposely sized. Writing paper must hold the ink. The ink must not be blotted as in the case of blotting paper or when writing on such unsized papers as wrapping paper or newsprint. All degrees of sizing quality can be obtained and various sizing materials can be employed. However, the most common of all sizing materials is rosin, the product that is obtained in the distillation of turpentine from the sap of pine trees.

In order to be able to use the rosin, it is first converted into a resinate by means of caustic soda. The resinate is soluble in water while rosin is not. This resinate is then added to the beater in which the paper pulp fibers are being comminuted and is made to combine in a definite proportion with water. After the rosin milk is added and thoroughly mixed with the fibers, the rosin is fixed on the fiber in a certain form by the addition of sulfate of alumina. This precipitates the rosin on the fiber. There are various theories regarding the exact reaction that takes place.

The pulp is then made up into paper, but the paper does not become truly sized until it has passed through the drying part of the paper-making machine, and the manner in which this part of the process, namely, the drying of the wet paper web is carried out is a determinate factor in securing a well-sized paper.

A Book on Tidal Power

WHILE the development of tidal power has attracted inventors for many years, no tidal power scheme of any appreciable size has hitherto been constructed. Specific schemes for large-scale developments have been under consideration in both Great Britain and France. Mr. Norman Davey has just written a book, "Studies in Tidal Power." Four million horsepower could be developed at 72 sites in the British Isles. Of these 49 are in England, 20 in Scotland and three in Ireland. At the present time, it is doubtful whether the development of any tidal power scheme designed as an independent unit to supply power for ordinary industrial purposes could be justified economically. On the other hand, there can be little doubt that if and when any chemical or manufacturing process becomes available in which electrical energy developed intermittently can be economically utilized as developed, the question of the utilization of tidal power will become of very great importance. Under such conditions no storage system would be required, and the cost of the energy would certainly be less than that of energy developed from any other source at present available. There seems little or no hope of success for small plants.

Gases in Industry and Home

THE FIRST gas known or used to any extent was natural gas, the gas that comes out of the earth. In ancient Greece, a shepherd was once wandering with his flock on a certain hill, on which the oracle of Delphi was eventually located, and suddenly for no reason that he could see, he was partially overcome and became hilarious, as if he had imbibed too much of the fermented juice of the grape. The townfolk saw in him and his plight incarnation of some evil spirit but the priestcraft of the country soon realized that here was an agency of which they could make use. Thus was founded the oracle of Delphi on a spot where natural gas issued from the earth and the priestess, being overcome by this earthy emanation, delivered the oracle of the gods.

Natural gas was, however, used in a practical way by the Chinese shortly after the opening of the Christian era for such purposes as the evaporation of salt from brine. It is said that certain houses in Pekin were heated—if not lighted—with the gas.

In Europe the first use of gas for commercial purposes dates back to the experiments made by Murdock, who lighted his home with it in 1792 and to the work carried to a more practical conclusion by Winsor. In the United States the first gas plant was established in Baltimore in 1816, which was followed by one in Boston in 1823 and one in New York in 1825.

Natural gas is still used in large quantities in the United States, although the limited character of the supply makes further development of its use impossible and in fact is already curtailing the present uses to which it is put. It is piped from the fields and used for cooking, heating and lighting in the home and is also employed for some industrial purposes. This gas possesses the highest calorific power of any gaseous fuel, possessing from 1000 to 1200 British thermal units per cubic foot. Almost all of this gas is constituted of the simple hydrocarbon, methane.

The manufactured gas that was first made was coal gas, that is, the gas that is obtained by the distillation of coal in the absence of air. At the present time large quantities of coal gas are used in this country and all over the world both in the home and in the industries. The gas is made in retorts, which are either horizontal, vertical or inclined and is collected therefrom, purified and finally distributed through the gas lines from the holder to the consumers. Coal gas is used to a large extent in industrial processes. Its calorific power varies according to the legal regulations. It is generally in the neighborhood of 400 to 600 British thermal units per cubic foot.

Water gas is a distinctly American development. The first successful water gas plant was put in operation in Phoenixville, Pa., in 1873. Water gas is made by the reaction of steam and incandescent carbon. The hot carbon breaks up the steam into hydrogen and oxygen and the oxygen combines with the carbon to give carbon monoxide. Thus water gas is essentially a mixture of hydrogen and carbon monoxide. Water gas is also known as blue gas for it burns with a blue flame. Blue gas has a calorific power of around 300 to 320 British thermal units per cubic foot. It is an ideal fuel for industry and for domestic consumption, for it carries the correct number of heat units to give a flame of maximum intensity of temperature and efficiency.

Carburetted water gas is also a fuel which is used to a large extent for domestic and industrial purposes. It is made by enriching water gas by mixing it with the vapors produced by the cracking of gas oil, a product obtained in the distillation of petroleum.

Producer gas is used in industry only. It is made by blowing air through a bed of hot coal. Its calorific power is low. Coke-oven gas is the gas that is recovered from the by-product coke oven in the manufacture of metallurgical coke and the recovery of tar, ammonia and other valuable by-products. Blast-furnace gas, recovered from the blast furnace making pig iron and oil gas, made from oil, are also of some importance.

One other interesting gas which is finding considerable use at the present time is known as semi-water gas. This gas is made in the producer from very low-grade fuels, even such products as crude lignite containing as much as 50 per cent water. In the manufacture of this gas considerable steam is blown into the producer, which is decomposed by the incandescent carbon, the products of the composition being mixed with other gases distilled from the fuel.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

An ingenious self-lubricating bearing of metal and oil-soaked wood

Bearings That Oil Themselves

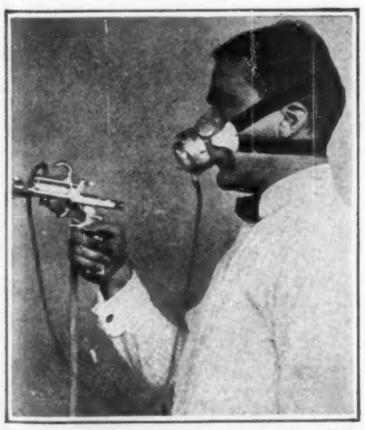
MUCH thought has been given of late years to the possibility of making bearings self-lubricating. We illustrate herewith what is, so far as our observation goes, a rather novel attack upon the problem. The bearing surface consists of a metallic lattice-work embedded in wood. As our photograph suggests, the inner surfaces of the metal and of the wood form part of a common cylindrical surface. The metal is supposed to take up the wear; the wood, soaked in oil, to supply lubrication for a very long period, and to be renewable in this respect by mere process of resoaking. Our picture shows the bearing partly cut away to reveal the constructional details.

New Fan for Manhole Ventilation

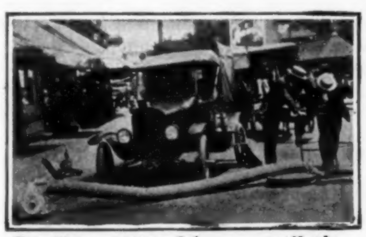
ONE of the problems in the daily life of the gas, electric light, street railway, and telephone companies is the ventilation of manholes so that men can work in them without feeling the effects of the gas which accumulates in the tunnel. In certain localities, the same question often troubles contractors in making excavations. Where it is possible to tap into a standard-voltage electric line it has been customary to use electric-motor-driven ventilating sets to pump fresh air down into the manhole through a canvas hose. This is all right where current is available, but it often happens that manholes in which ventilation is essential offer no facilities for tapping wires. In these cases the telephone and other companies have for years used manually operated geared forge blowers. The amount of air which these forge blowers can furnish is limited, so that often two are necessary; and turning the crank not only ties up one or two men, as the case may be, but it is monotonous work, of which the men are apt to find a little more than enough.

One of the telephone companies recently put the problem up to a large blower concern and asked them whether they could not furnish a gas-engine-driven unit for this work. The fan company has developed and is now marketing the little direct-connected blower shown in the photograph. This was taken during the demonstration of the blower to the officials of the telephone company, who, incidentally, were entirely satisfied with its performance.

The engine is a standard commercial unit, four cycle, with a single cylinder $2\frac{1}{4} \times 2\frac{1}{4}$ inches and develops three-quarter horsepower at 1800 revolutions per minute. The gasoline tank and oil reservoir are located in the base of the engine, and the magneto is built into the fly wheel, so that no auxiliary tanks or batteries are necessary. A governor provides for regulating the speed. The fan will deliver volumes ranging from 775 to 1050 cubic feet of air per minute, depending upon the speed at which the engine is operated. As the unit weighs only 85 pounds, one man can carry it anywhere; and as it will run ten hours on a gallon of gasoline, the cost of operating it is small. Where it displaces two forge blowers, it will soon pay for itself through the saving in the helper's wages. So far as the manufacturers know, it is something new in the ventilating line, and they believe that all the public utility companies will find it worth having.



Paint-spraying mask that stops the danger of lead and arsenic poisoning through inhalation of the spray



Gasoline-engine-driven ventilating fan for keeping manholes clear of gas, snapped at work

Taking the Poison Out of the Paint Spray

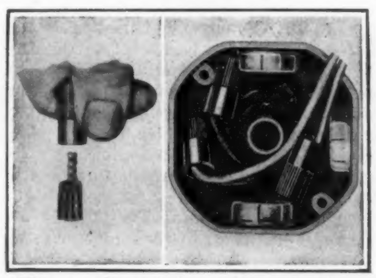
SPRAYING as a means of attaching paint to its surface is a procedure that is coming more and more into vogue, being used in a wide variety of factory operations on large and small manufactured articles, as well as in outdoor structural works. But the paint-spraying process is one that, till now, has been accompanied by at least one rather serious factor. You can't spray paint without having more or less permeation of the atmosphere by the fumes; and paint contains arsenic and lead, which make it anything but desirable for breathing purposes. A recent attempt to obviate the dangers of poisoning from this source includes a little gas-mask member, which is actually joined to the same air blast that operates the spraying nozzle, so that the painter breathes under forced draught. There are separate needle valves for controlling the pressure to the nozzle and to the mask, so that they may be varied independently. The air that goes to the painter's nostrils is filtered through moist sponge.

Wire Nuts

HERE is a better, easier, neater way to make a splice in wires. Simply twist the ends of the wires together, screw on one of these little wire nuts, and the job is done. There is no need of soldering and no need of taping. The protection against contact with outside things is so good that wire nuts have the approval of the Underwriter's Laboratories.

When one examines the inside of the wire nut he finds it has a brass lining which is tapped out with a right-hand thread and is split lengthwise in four pieces, the split not extending all the way down, of course. This permits it to expand to a certain extent to take slightly off-sizes of wire.

These connectors come in a number of sizes. There is a No. 14 and a No. 12 nut, and they take from one to three wires, either No. 14, No. 12 or No. 18 stranded. They cost around a cent apiece, list.



The nut for splicing wires, showing the way it works, and the way it looks when used in an outlet box

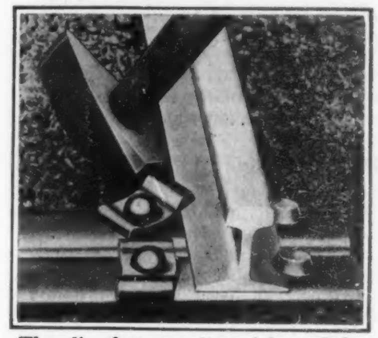
The insulation is bakelite and it extends about one-half inch beyond the brass lining, this being for the obvious purpose of covering the shank of the wires considerably above the connection.

Speed is one of the chief advantageous points favoring wire nuts. Figuring a man's time, can he make up a regular connection and solder it for a cent's worth of time? He would have to do it in less than a minute if he did. But the wire nut screws on in a jiffy, a pocketful being enough for a day's work, and it makes a fine connection, the brass threads cutting into the wires deeply. Wire nuts are the product of a New York manufacturer.

Steel Ties for Mine Railways

ORE and coal are generally brought out of mine headings to the hoisting shaft by means of cars holding comparatively small quantities. To make this short-distance transportation possible, rails are laid down temporarily on ties which, of course, are not required to be very heavy. In place of the old wooden tie modern mines are now using ties of rolled steel section.

Steel ties are strong yet portable, a miner being able to carry ten or fifteen of them on his shoulder. They are not thick, thus allowing a gain of headroom in mine passages where every inch of headroom counts. This makes possible a slightly greater loading of the cars. These steel ties can, according to the Bethlehem, Pa., manufacturer, be used for an indefinite period of time, taken up, moved and put down again many times. Wood ties under similar treatment are said to be usable only once or twice before they wear or rot out.



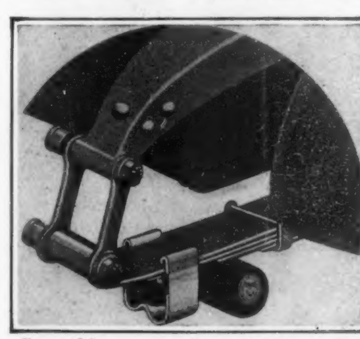
The clip that permits quick work in setting up portable railways with steel ties

These ties are equipped with a simple but ingenious method of clipping the light rails. The locking clips may easily be turned into position by means of a hammer or an axe. They are held in place by means of a rivet. The tie is simply slipped under the rail, the buttons (at the right in illustration) engage the rail as the tie is moved sidewise, and the clips are turned, locking the rails. This permits the extra insertion of ties without taking the track apart to string them on the ends. One clip will ordinarily hold the rail in place securely, but there is a reserve clip in case the other is injured.

A Simple Stabilizer for the Car

A SPRINGFIELD, OHIO, manufacturer has found a new way to save us thumps and bumps on roads that are "shocking." The device which effects this is called a stabilizer and it is designed to be attached to the car spring. It consists of a weight which is attached to the chassis spring just forward of the spring shackle by means of a clip which is snapped on. The operating principle is very simple. When a bump is traversed by the car the chassis spring is deflected, the weight is thrown in a downward direction and owing to its inertia it tries to continue to go down. The other end of the arm on which the weight is mounted then exerts a great pressure against the leaf of the spring next to the upper or master leaf. The two are pressed together, the lateral motion is damped, and this damps the rebound.

There are three sizes of stabilizers, for $1\frac{3}{4}$-inch, 2- and $2\frac{1}{4}$-inch springs. There are only three parts to the stabilizers, the spring, made of oil-tempered spring steel, the body casting, and a galvanized tension bolt to lock in adjusted position.



Something new for checking the rebound of the car springs

The electric ironing outfit that eliminates ironing on the end of a cord

Electric Irons Without the Cord

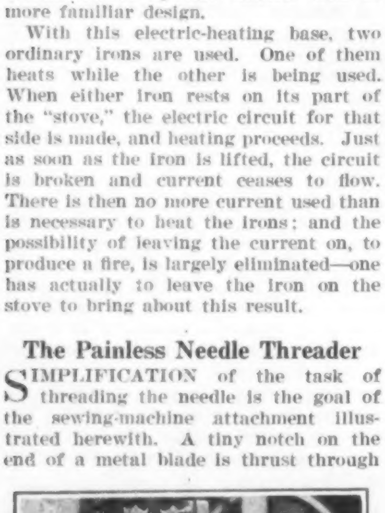
THE electric iron is a great convenience, but just on this account we should not blind ourselves to any drawbacks which it may possess. As conventionally offered, it does possess disadvantages. The cord that joins it to the socket is a fearful nuisance—continually jerking the iron, continually getting twisted on itself or on something else, continually sweeping clean handkerchiefs and other small articles on to the floor. Moreover, with the current flowing steadily as is necessarily the case, the iron consumes more juice than is really necessary, it overheats, it wears out the electrical parts before they need be worn out, etc.

The new electric-iron equipment illustrated avoids all this. The original advantage which recommended the electric iron lay in the fact that the repeated trips to the stove were obviated by its use. The new assembly provides in reality an electric stove for the iron, rather than an electric iron; but this stove being on the end of a cord just like the electric iron, it can be put down at the ironer's elbow and the trips across the laundry floor are just as effectively eliminated as by the electric iron of more familiar design.

With this electric-heating base, two ordinary irons are used. One of them heats while the other is being used. When either iron rests on its part of the "stove," the electric circuit for that side is made, and heating proceeds. Just as soon as the iron is lifted, the circuit is broken and current ceases to flow. There is then no more current used than is necessary to heat the irons; and the possibility of leaving the current on, to produce a fire, is largely eliminated—one has actually to leave the iron on the stove to bring about this result.

The Painless Needle Threader

SIMPLIFICATION of the task of threading the needle is the goal of the sewing-machine attachment illustrated herewith. A tiny notch on the end of a metal blade is thrust through the eye, pulling the thread in a loop with it. The loop itself is then pulled through, and threading is a *fait accompli*. The work of this little device is so perfect, after the simple motions have been learned, that many blind people are using the attachement. Though built primarily for sewing-machine use, the device is obviously available for hand sewing as well.



This attachment threads the needle in two rapid, easy motions

The Universal Grater

AMONG recent clever devices for the housewife that have come to our attention, the grater with interchangeable units which is illustrated occupies a high place. Heretofore, it has been necessary to have several different graters of this pattern in the well equipped kitchen. The German inventor who is responsible for the present design makes one framework do the work for all, and he provides an extremely simple and rapid means of interchanging the grating units, as the picture indicates. He also provides for the compact and easy storage of the entire outfit in the pantry; the grating member last in use remains in place, while the other two are accommodated on the other side of the standard.

The Quantity-Production Electric Toaster

ELECTRIC toasters of such size and capacity as to be useful on the dining room table are familiar to most of us. The picture herewith shows the application of the same idea on a larger scale, and in a way which probably few people other than professional cooks have seen. These automatic electric toasters are made with a capacity up to twenty slices at a time. They toast with such rapidity that, in the cadet mess at

The electric toaster that makes toast for 1200 breakfasts in a half-hour

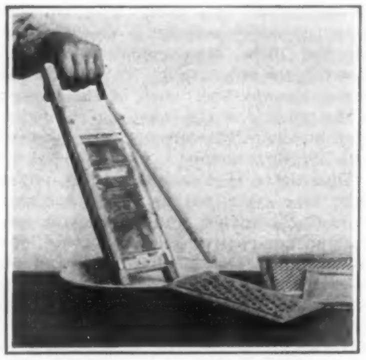
West Point Military Academy, toast is made for 1200 cadets in about half an hour. The toaster is operated by simply inserting, just about as fast as the operator can do it, the slices of bread in the slots at the left. The bread is automatically carried between two electric units, which toast it simultaneously on both sides; after which it is automatically discharged into a container at the other side of the toaster. The toast comes out hot clear through, and is kept hot in the container until served.

The Vector-Ruling Protractor

SEVERAL years ago, A. F. Zahm described a vector slide-rule for determining a vector in magnitude and position when given its components and its moment about a point in their plane. But frequently it is necessary to know only the line of the vector, and not its magnitude. The same author, in a paper presented to the Franklin Institute (*Journal*, February, 1924) shows how this can be done by the use of a circular protractor and a guiding straight-edge along which it may move. The apparatus has been devised chiefly for aeronautical work.

The Prongless Strap Buckle

STRAP buckles that require holes in the strap, with prongs in the buckles to engage these, offer always the possibility that the hole will tear out, releasing the prong and spilling the load under the strap. Numerous prongless buckles have been offered, but seldom have we seen so simple a one as that herewith illustrated. The manipulation is simple, as the photograph will suggest—it is simply a matter of exerting a little pull in just the right fashion. Among the collateral advantages of the absence of prongs is mentioned the fact that the prong is very likely to stick into the fabric or leather of the bundle, or even to catch and tear the user's finger.



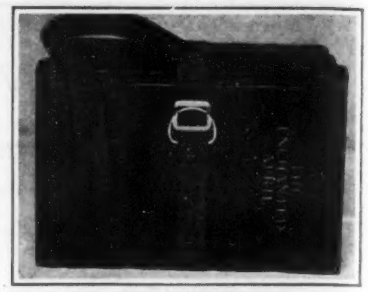
The kitchen grater with interchangeable slides

The Sun Compass

ONE of the most difficult problems to be faced in preparing Amundsen's contemplated flight across the North Pole was the designing of some suitable means of navigation. How is the celebrated traveler to find his way through the eternal ice, how is he, in the absence of any reliable maps of those arctic parts, to steer his machine due North? That the magnetic compass used in ocean travel as well as in normal aerial navigation would be of little avail to the pilot through the northern ranges of the atmosphere, the following considerations will serve to show:

As the magnetic pole does not coincide with the geographic North Pole, the compass dial during a flight across the Pole is bound unceasingly to shift direction, and inasmuch as the declination of the needle in arctic regions is not known with anything like sufficient accuracy, this could hardly be made up for. Moreover, the rapidly waning direction force of the magnetic needle on the pilot's approach towards the magnetic Pole, coupled with its growing sensitiveness to disturbance due to acceleration of the airplane and the frequency and violence of magnetic disturbance in arctic regions, added an even greater difficulty to the above, nay, made of any attempt in this line a hopeless task from the very outset. Nor could a gyroscopic compass be used with any better chances of success, this type of instrument, apart from its enormous weight, likewise failing to function in the vicinity of the geographical North Pole.

The only possibility left open thus would be to guide oneself by the sun. In latitudes such as our own, where the magnetic compass works very well, the orbit of the sun on its daily revolution is inclined too far to the horizon to afford a safe means of guidance, but the sun in polar regions travels at practically constant height around the horizon, and accordingly constitutes an ideal natural clock. In fact, any ordinary clock could under these conditions be used as

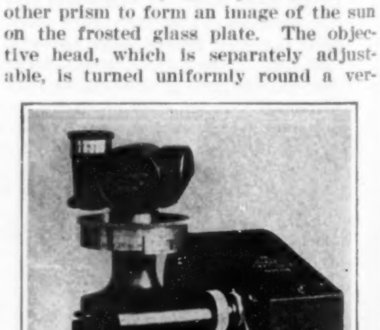


The strap buckle that has no prongs to tear the strap, the load, or the fingers

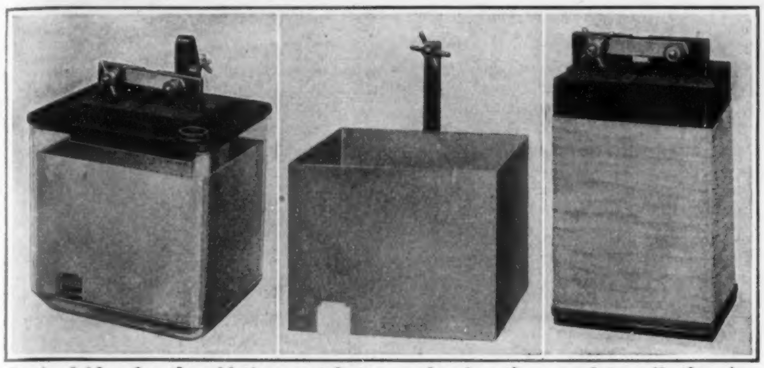
a compass, though this method would be too roundabout to afford a satisfactory solution.

Under these circumstances Captain Amundsen has arranged for the manufacture of a sun compass—a small instrument about 20 centimeters high, mounted on the machine in front of the pilot so as to leave the head of its objective free to protrude in an upward direction. The pilot, previous to starting, adjusts this instrument to the course desired and sets the clockwork running. For the sake of convenience, the clockwork should be set to Greenwich time, after which the machine is started, being steered so as to have a miniature artificial sun appear all the time in a division of a frosted glass plate. Towards this artificial sun the pilot will have to steer his course, for this invariably points the direction of his flight. Let the sun shift its position to the front, to the side, or to the rear, the pilot need not trouble about that, provided that the artificial sun is there to show him the way. If he wants to do anything more than the strictly needful, he may from time to time check the time of the compass clockwork by his own watch. As long as the two timepieces agree with one another, he will be sure to keep his course. Whenever, on account of some sudden gust or for any other reason, the course is to be altered in the midst of the flight, he only has to turn the objective head of the instrument through the angle required, in order afterwards again to fly towards the artificial sun.

The mechanism of the machine is simple enough. The beams of light from the sun fall on a prism which, according to the actual height of the sun, can be adjusted by means of a small set-screw visible in the head of the instrument. After being reflected from this prism, the beams will pass downward along the longitudinal axis of the instrument, to be recombined by an objective and another prism to form an image of the sun on the frosted glass plate. The objective head, which is separately adjustable, is turned uniformly round a ver-



The sun compass used in polar aviation



Revised idea for the old-time wet battery, showing the complete cell, the zinc element, and the carbon element

tical axis by clockwork, thus accurately following as it were the sun on its revolution. An additional prism inserted in the course of the beams coming from the sun and turning at half the speed of the objective prism serves to keep the image of the sun upright independent of the actual position of Old Sol.

New Waterproof Glue

A HIGHLY water-resistant blood albumin which can be applied without the use of a hot press has been invented by A. C. Lindauer of the Forest Products Laboratory, United States Forest Service. The development of this glue is the latest and most promising advance made as a result of the long continued research by the government laboratory for a satisfactory waterproof glue for wood. The blood glues now used show considerable resistance to moisture, but all require pressing in a press with steam-heated plates, which is a relatively slow process, calling for very expensive equipment. The new glue, which is made by the addition of paraformaldehyde and ammonia to blood albumin, can be used with presses of the same sort used in gluing wood with animal, vegetable and casein glues. The cold press blood glue has greater water resistance than any casein or blood glue hitherto tested by the laboratory and has sufficient strength for use in plywood. Plywood test specimens which were placed in the fungus pit of the Forest Products Laboratory under conditions of excessive moisture for a period of one year required a shearing force of 300 pounds to break them apart, and specimens submerged in water for a period of one month proved to be equally strong. The U. S. Navy specifications for water-resistant plywood specimens of the same type require only a strength of 180 pounds after soaking for two days. The fungus pit condition endured for even a few months is known to be more severe than a two-day submergence test. The ease with which the new blood glue can be spread and molded and its high water resistance may lead to ousting glues now in use.

A New Career for the Old Wet Battery

MOST of us are familiar with the old-time wet battery, with its glass jar, its sal-ammoniac solution, its large carbon cylinder, and its pencil of zinc. Such a battery was in wide use until the dry battery became entirely practical, especially with regard to chemical stability. For bell work and other applications requiring intermittent use of electric current, the old wet battery performed fairly well. But when it came to large outputs of electricity over a period of time, it ran down rapidly. Indeed, all in all, this form of battery had a very limited application.

It has remained for a French carbon manufacturing company to take the old wet battery principle and study its shortcomings, following up this work with an improved type of wet battery. The new battery, which is represented in the accompanying views, has the usual elements—a carbon electrode, a zinc electrode, and a concentrated solution of ammonium chloride, utilizing the oxygen of the air as a depolarizer. The carbon electrode in this case is extremely porous and of a cellular structure, so that it is impervious to liquid but will freely admit gases.

During the process of discharge in this type of battery, hydrogen is given off at the zinc or negative electrode, passes over to the carbon or positive electrode and is absorbed by it. The peculiar construction of the carbon allows the rapid adsorption of oxygen which, combined with the hydrogen, forms water, and which in turn is passed back into the battery, thus cleansing the surface of the carbon and preventing polarization. The voltage is thus maintained constant for a given rate of discharge. It is to be borne in mind that the inside of the carbon remains dry at all times.

A single cell of the new battery is capable of delivering very heavy current rates in intermittent service, and at a three-ampere rate, such as in railway signal service, there is but a minimum voltage drop. The rapid recuperation of voltage is one of the chief characteristics of the cell. There is at first a peak voltage which very rapidly diminishes during the first 24 hours of service, and thereafter what may be considered as the working voltage is maintained during the ampere-hour life of the cell at between 0.95 and 0.75 volt. The new cell is conservatively rated at 600 ampere-hours at a constant discharge of 250 milliamperes. The carbon element is conservatively rated at 1800 ampere-hours, or the equivalent of the life of three zincs. After the first 600 or more ampere-hours have been obtained, as indicated by badly perforated or lacey zinc, the cell is dismantled, the glass jar is washed, the zinc is renewed, the carbon element is cleaned by detaching one of the layers of linen which wraps it and the bottom of the carbon is scraped with a piece of wood or knife, following which the cell is reassembled and filled with fresh electrolyte.

As will be noted from the illustrations, the elements are contained in a rectangular glass jar, the zinc being of approximately the same shape as the jar—box-like without top or bottom—and the carbon element positioned within the zinc and properly insulated from it. The lower end is encircled by a heavy rubber band and held at the top in the proper relation to the zinc by the cover through which the carbons extend, allowing them access to the air in order that they may breathe oxygen. The electrolyte consists of a specially prepared ammonium chloride or sal-ammoniac which, when mixed with the proper amount of water, will give a concentrated solution.

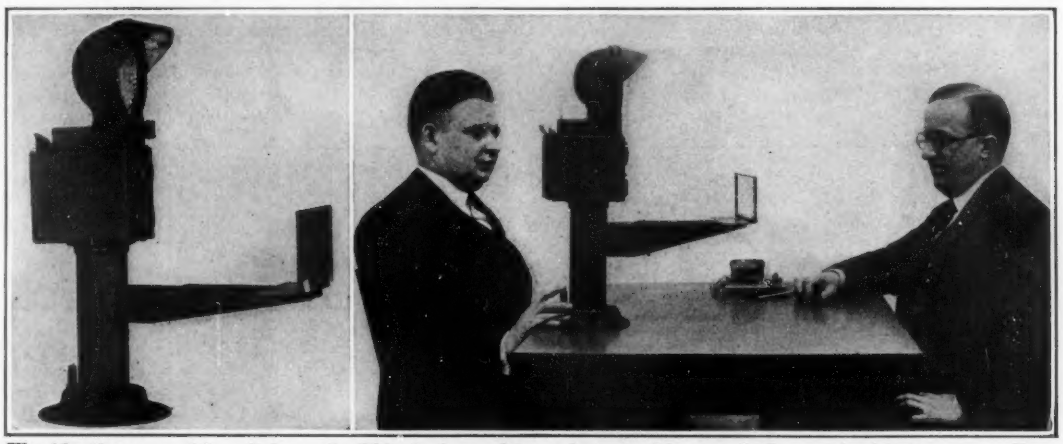
The revamped sal-ammoniac wet battery is available for a number of different uses, such as railway signalling, telephone work, bell systems, radio, and so on.

Your Face as Well as Your Signature to Protect Your Checks

PHOTOGRAPHIC reproduction on one negative of both the face of the check-writer and of the check he has signed is the principle of a new machine for the prevention and detection of forgery. This new device, which is called the identiscope, is the invention of Victor Ernest of Cleveland, Ohio. Mr. Ernest, who is nationally known for his work in the detection and proving of forgeries, has taken advantage of the fact that a photograph offers the most successful method for the capture of the forger.

The identiscope, which is shown in the accompanying illustrations, is a novel type of camera rigidly mounted and automatically focused. Indeed, it can be operated by anyone. A holder receives the check or signature card and is always in line between the lens and the subject to be photographed. Two fixed focus lenses are used, one for the document and the other for the subject. The operator merely presses a button, a light glows up pleasantly to illuminate the check or signature card as well as the subject, and the negative photographic record is made. This negative photographic record includes the check or signature card and the face of the subject, a print being made from the negative and filed for reference.

If a bank teller or cashier is in doubt concerning a check that is presented, he can immediately refer to this photographic record and compare the face at the window and the signature on the check with an accurate likeness of the customer and his known true signature.



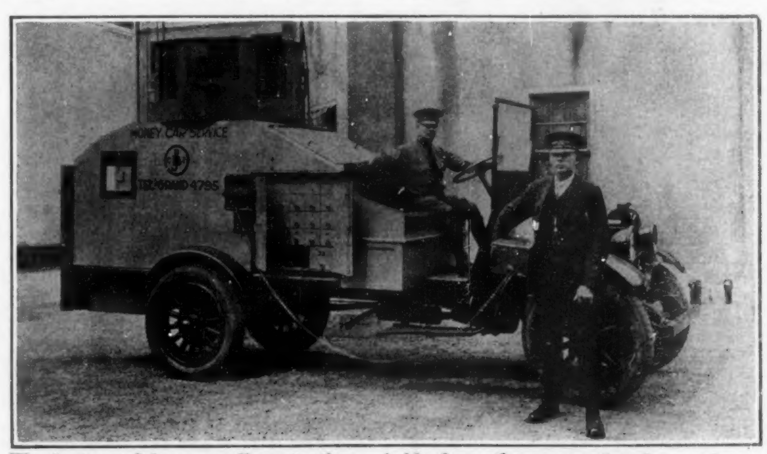
The identiscope and how it is used. This device makes a photographic record of a man's signature as well as his face, for the future identification of checks and other signed documents

The identiscope has many other uses in addition to bank and hotel protection, such as criminal identification, industrial records, fraternal identification cards, and so on.

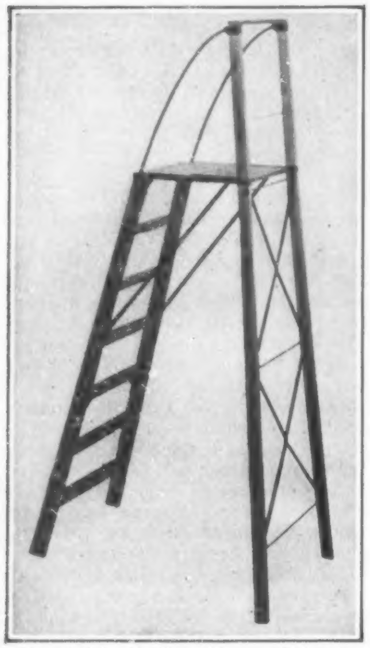
The Last Word in Pay-Roll Protection

ALL a Kansas City pay-roll or bank messenger will have to do hereafter when he is held up, while in the possession of a large sum of money, will be to drop the steel box in which he is carrying the money and other valuables. The box is attached to a 150-foot steel cable, and the cable will be automatically wound up so as to draw the box into a steel armored motor car waiting nearby.

The accompanying illustration depicts this last word in pay-roll or bank messenger protection. The money and valuables are placed in individual steel boxes which are inserted in the compartment shown. Then each box is connected with the cable and reel. Meanwhile, a guard is stationed in the revolving turret with guns ready for instant action.



The last word in pay-roll protection. Aside from the armored and armed car, the money and valuables are placed in a steel box at the end of a steel chain or cable. When in trouble the messenger drops the box and it is pulled back into the armored car



Step ladder built with special reference to the ladder accidents that commonly occur

A Ladder That Prevents Accidents

TWENTY thousand persons are killed or injured annually in industrial plants by falls from step ladders, according to accident statistics. This number would be largely increased if figures were compiled covering accidents in homes and other places, of which no record can be kept. Wherever step ladders are used there is an ever-present accident hazard and an opportunity for the applications of safety engineering.

A great deal of study has been given this form of danger with the result that a safety ladder has been perfected. The frame is of airplane spruce thoroughly reinforced with steel. A block is inserted beneath the step and a steel rod drawn up tight to insure strength and safety. It is claimed that it is impossible for a step strengthened in this manner to break loose, slip or collapse. There is a wide spread between the legs which prevents the ladder from shaking or upsetting, and enables it to straddle machinery or other obstructions.

Workmen on any step of the ladder or on the platform can lift, push or pull without danger of a fall. There are five horizontal steel rods between two rear legs, and in addition all lateral play is prevented by cross-bracing of two flat steel trusses which are bolted at the center and solidly to the frame. At the top, side rails are provided which are used in climbing, and also provide an additional brace. The side rails inspire confidence in the use of the ladder and enable the user to work at the very top without a feeling of danger.

The platform provides a place for tools or material for the job, and is large enough to accommodate two workmen when needed. This platform is so constructed that half of it may be conveniently raised to provide an auxiliary step about an extra foot in height. When the ladder is opened the working platform and braces fall into places naturally, requiring no adjustment. The ladder is closed up by pushing the front and rear members together, the braces and platform operating automatically. It cannot close up when any weight is on any step or platform.

The safety legging for protecting foundrymen against leg and foot burns

Why Foundrymen Burn Their Feet

FOUNDRYMEN who pour molten metal from ladles very frequently burn their feet or legs very severely owing to the splashing over them of the metal. Many of these workmen wear old and practically worn out shoes purposely in the foundry and when the hot liquid metal falls upon them it often finds its way through cracks and breaks in the leather. There have been many serious accidents of this sort, not to speak of the unreported minor ones.

A Philadelphia manufacturer has provided a special legging for the purpose of obviating burns to the legs and feet. This legging covers the entire foot, for it is rather on the flatter parts of the foot that the melted metal gets a "foothold" long enough to burn or sink through to the flesh. They are not, as one might at first surmise, made of asbestos—the best reason for this being that in practise, experience shows that they do not have to be. The protectors are light in weight, very much like the army legging, and do not cramp the feet or delay the motion. They lap at the back and may be put on in a jiffy.

It is often quite easy to devise an ideal protection for workmen of various sorts, but the result of this sort of effort often reminds one of the usual result of preparing a nice, cozy bed for a cat. The bed will perhaps seem ideal, but puss won't use it. So with the men; the safety appliance must meet the "human nature" test first, and ideal as it may be, if the men don't like it, they simply will not wear it.

The protecting legging for metal pourers appears to have passed the human nature test, and is now being worn daily by a large number of these workmen. This, in the main, is simply because they have found it is really practical and does what it is designed to do.

The Portable Car Hoist

FREQUENT need of making repairs on the trucks of railway cars make it just as necessary for railroad repair shops to have jacks as for the user of a flivver. In some shops this sort of thing is done with ordinary hand jacks, and it is a slow, expensive process. Worse than that, when noon hour or night comes it is generally necessary to "unjack" the car, since rules of safety make it inadvisable to leave it hanging in the air on blocking that may be dislodged.

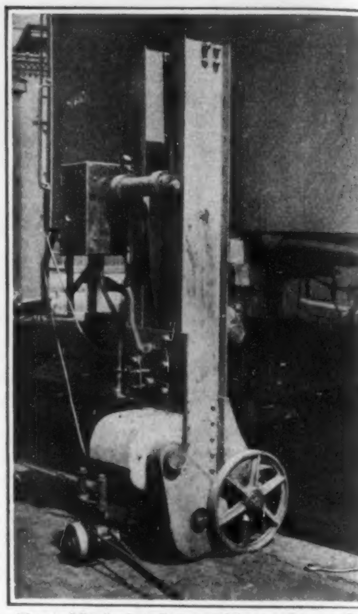
Some large shops have regular, set hoists—the car being run in on a spur of track, spotted over the hoist and left. Four power-driven spuds then come up out of the earth, to all appearances, and boost the whole car-body up off the trucks. These are as applicable to locomotives as to cars, so that a heavy engine may be unwheeled very rapidly.

But smaller shops which cannot afford and do not often need such ideal outfits may now use the portable hoist, which is manufactured by a Harvey, Ill., manufacturer. This consists of a portable truck carrying a machined steel screw of ample diameter mounted on a worm gear and housed by a structural frame. The projecting step or support by which the car is bodily lifted rests on a bronze nut on the steel screw. Power is supplied by an electric motor.

Portability is obtained by means of a toggle mechanism which lifts the base of the hoist off the ground high enough to put the weight on the wheels, allowing the hoist to be pulled from place to place like a small truck.

After being moved into position alongside the car, a reverse movement of the toggle device lowers the hoist so that its three bearing surfaces rest squarely on the floor.

This hoist does not require a special foundation or pit, but may be used on any level floor capable of sustaining the load. No air or water lines are required, the power being brought to the hoist by means of a flexible conducting cord.



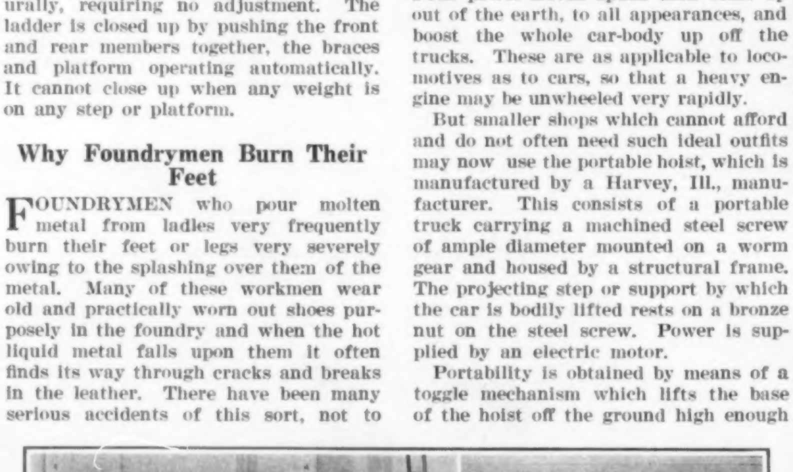
Portable hoist for rapid repair work on railroad cars

The Folding Breakfast Room

THE old-fashioned breakfast ceremony has happily given way to the simple breakfast. New houses are being equipped with special breakfast nooks, often in the kitchen—for there's a kind of charm about the kitchen, at least in the morning, that makes dining there enjoyable. If breakfast is a simple meal eaten elsewhere than at the more formal dinner table, one feels safer in taking the risk of appearing for breakfast in negligee.

People who live in city apartments become jealous of every square inch. If the apartment is small it is literally true that there isn't spare room to store a fair-sized bundle. Places of this sort should be equipped with the breakfast room invented by Walter C. Fain, of Norfolk, Virginia. The two illustrations tell the story. The whole thing—table and two benches for seating four diners—folds up and disappears in the wall behind neat doors. The foldaway breakfast room requires only eight inches of depth space in the wall. Open the doors, let down the table, the two benches, set the table. Then demolish the breakfast. That done, reverse the process, closing the doors and "there's nothing to do till tomorrow."

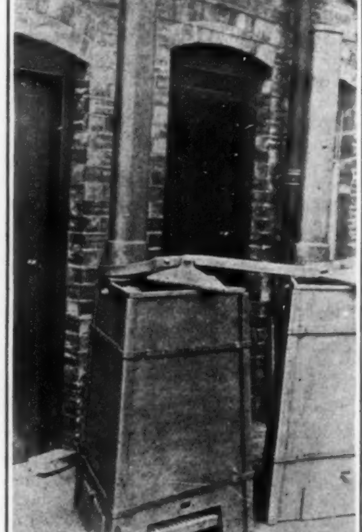
In addition to the breakfast room there is a dining room which is about the same thing on a bit larger scale. You can wheel the tea-wagon or the radio set in front of the doors during the day and no one will then try to walk through them.



The disappearing breakfast outfit, in use and in repose

A Baby Incinerator for Waste Materials

ONE of the problems of civilization is the disposal of "town waste"—the material thrown away by the housewife and, necessarily, taken up by the town authorities or by contractors working under town authority. Such waste is usually destroyed by burning, but the



Portable furnace for disposing of the garbage and other refuse of civilized life, on a small scale

problems involved are not simple. The refuse material contains, in general, only one-third (more or less) of combustible matter. One-third is moisture, and another third is incombustible material of the sort that must be withdrawn from the furnace as clinker. The temperature required for the destruction of septic poisons in the products of combustion has been stated to be about 1250 degrees Fahrenheit, and the gases escaping from the main flue must not be permitted to fall below this temperature. The higher the temperature at which the clinker is withdrawn, the greater the heat losses from the incinerator.

It might seem that these problems were so complex as to offer no hope of solution in any small installation of portable nature, yet this has been found not to be the case. A British manufacturer of large brick incinerators has succeeded in applying the principle employed in these, to a small triangular furnace of metal, which we illustrate. This incinerator can be packed into small compass, and can be set up in a very few minutes by erecting the three sides and the three corner angle-irons, and knocking the two triangular hoops down into place with a hammer. As a sample of its use, it has been found of great value in disposing of the waste and facilitating the sanitation in the British settlements in Gold Coast; and it should be useful wherever small communities of civilized persons exist.

One-Man Tractor for Heavy Cable Reels

THE unwieldy shape and tremendous weight of cable reels make their handling a very difficult problem. Most companies concerned in the production or use of cable have been obliged to employ gangs of four or five men with pinch bars and other simple tools to maneuver the reels from place to place.

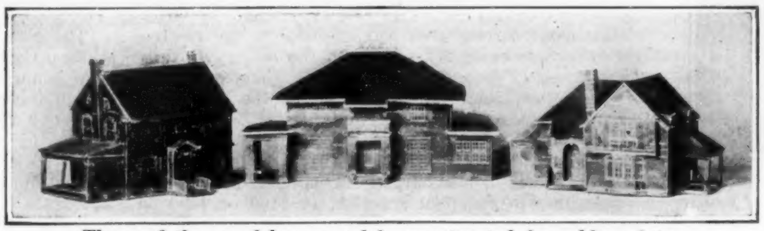
Now comes a trailer which in conjunction with an electric tractor will handle cable reels of any size and of any weight up to five tons, with one man. This trailer consists of a structural steel frame heavily braced and reinforced, providing an opening into which a reel fits; a lifting device for raising and holding the reel in position; and sturdy wheels on which the trailer and its load can be pulled by the tractor.

The motive power for lifting the reel is supplied by a heavy duty motor, drawing its power from the batteries of the tractor. When the trailer has been backed to bring the reel within the trailer frame, a shaft is placed through the center of the reel extending over curved prongs, or fingers, attached to the lifting member on each side of the trailer. These lifting members are then raised by vertical screws, worm-driven from a horizontal shaft connected to the motor by a silent chain and sprocket wheel. The entire control of the reel-lifting mechanism is so arranged that it can be handled by the tractor operator from his seat.

A number of safety features are incorporated in the control arrangement so that the reel can be lifted only to a predetermined height and held securely there while moving. Automatically operated brakes are also used to prevent any coasting effect. The wires connecting with the battery pull out in the event that the trailer becomes uncoupled.

Mining Coal with Black Powder Is Dangerous

DESPITE the invention of more effective and safe explosives a vast amount of black powder is still used in mining coal. Figures for 1922 issued by the Bureau of Mines show the ratio between the amount of other explosives and the old black powder used. For each 1000 tons of coal mined in that year 87 pounds of permissible explosives and 56 pounds of high explosives were used; as against 336 pounds of the old black powder. A permissible explosive is one which corresponds in all respects to the sample which has passed certain tests prescribed by the Bureau. This class



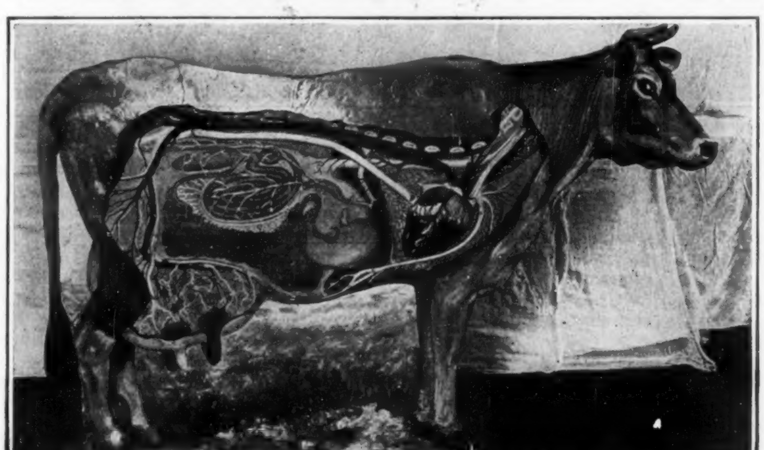
Three of the novel house-models, constructed from blueprints

includes ammonium nitrate explosives, hydrated explosives, organic nitrate explosives, and certain nitro-glycerin explosives containing an excess of free water or carbon, and which meet the requirements of the Bureau's definition. Under high explosives are classed dynamite and all other high explosives of various trade

Tractor that enables one man to handle heavy reels of cable

names and compositions excepting permissible explosives. The third and comparatively dangerous class consists of plain black powder with sodium or potassium nitrate as a constituent. This is issued or sold to the miner in kegs.

As regards safety, the ease of ignition and the promptness of explosion there-



Displaying the working parts of Nature's milk factory

after, permissibles are far superior to black powder. The permissible explosives of the ammonium nitrate class are especially difficult to ignite, and many of them will not continue to burn unless heat is added from an outside source. Accidental explosion will not usually result, the Bureau states, from ignition unless they be confined, and then not with any degree of effective certainty.

In brief, the Bureau's tests have shown, and actual coal mining operations have verified them, that the permissible explosive has a very much shorter and cooler flame than black blasting powder, and a very much cooler flame than other high explosives. This is the most important physical characteristic of permissible explosives and permissibility depends primarily upon it.

Experience and experiment have both produced abundant evidence that black blasting powder, because of the ease with which it explodes after ignition, and the unsuitableness of the metal kegs in which it is customarily marketed, is more dangerous in use than any other common industrial explosive. Miners, quarrymen and laborers, finding that the bunghole of the keg is too small to permit the quick emptying of the powder and that all the powder cannot be emptied out, resort to the dangerous practice of opening the keg with a pick, shovel or bar and the accidents and fatalities resulting are far too common.

The combinations of black blasting powder and gas; or black blasting powder and coal dust; or black blasting powder, gas, and coal dust, are vicious hazards, all of which have resulted in terrible disasters.

Making House Models from Blue Prints

IT is difficult for the average layman to visualize his home correctly through the architect's blue-print drawings. Quite often, the finished product looks altogether different from what the owner had in mind, even though the plans were explained in detail and gone over carefully. This is because flat drawings do not show the actual surface angles.

Miss Ethel Bartholomew, Minneapolis, architect, has originated a print model plan which promises to remedy this condition. Instead of showing her clients the technical and intricate craftsman's drawings, Miss Bartholomew constructs from the blue prints—or black prints made from the blue prints—a model of the home. The result is a perfect miniature of the home, enabling her client to detect and correct objectionable features or unpleasant lines which he or she would be altogether unable to detect in the flat drawings.

The roof, the cornice work, dormers, gables, porches, projecting bays, even the landscape gardening, are included in the model. The roof can be lifted, revealing the upper floor plans. Likewise, the upper floor can be removed revealing the plans of the ground floor. The model eliminates any future misunderstanding on the part of the client.

Determination of the Place of Origin of Seed

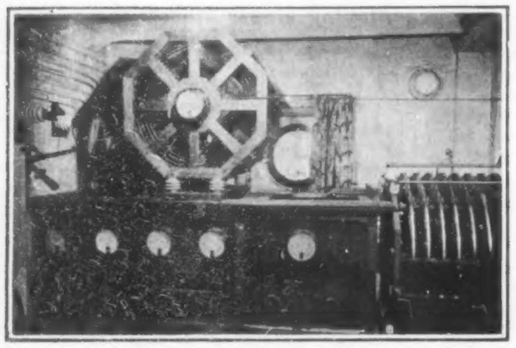
BUT in very few cases is it possible to determine from the appearance of the seed the place of its origin, as seed of most cultivated plants, looks exactly alike, independent of the place of growth. For this reason, a farmer often encounters heavy losses through buying superior-looking seed, and finding about the autumn that the crop is not ripe as yet, and is therefore lost.

A long series of experiments conducted by the staff of the Botanical Garden of Leningrad (lately Petrograd) led ultimately to the discovery of an infallible method of determination of the place of origin of the seed in question. This wonderful feat is accomplished by simply identifying what weeds are present, for it is practically altogether impossible, as experts can confirm, to remove the last traces of this admixture. Now it is equally well known that every region of the country has its own particular "set" of weeds, or perhaps, a certain proportions among the different constituents which make it up. Through a careful definition of weeds that are met with in any part of the country it becomes quite possible to identify instantly any seed that comes from this particular location.

A number of tests carried out in Moscow allowed not only to determine what region of the vast U. S. S. R. did the seed come from, but in some cases even the province could be definitely named.

What Makes the Cow Go?

IN this large model of a cow used by the United States Department of Agriculture in exhibit work the circulatory system is shown through means of veins, arteries and heart of rubber. An air pump is attached to the system in such a way that the heart and arteries pulsate noticeably at a normal rate. The heart is made of a hot water bag. One of the objects of this visual method is to show the difference in the proteins provided by various feeds. The cow model is designed to show how the proteins of the feed are broken by the digestive system into the constituent amino acids, which are transported in the blood stream to the udder, where the necessary amino acids are taken out of the blood and built up into proteins of the milk.



The new and powerful radio installation of the S.S. Paris of the French line

Our Radio Page

Listening-In on the Latest Progress of the Broadcasting Art

Keeping the Set in Shape

WITH the coming of the fall and long cool nights, ideal for radio reception, many radio enthusiasts will vie with one another in the reception of distant or D. X. stations. To be the proud possessor of a set that will enable its operator to have at his command the programs of so many stations, both far and near, is the ultimate goal of every beginner at this fascinating pastime.

Many small details enter into the proper care of a set if maximum results are to be obtained. It is often necessary to check up on these details to have the set function properly. Care should be taken to see that the antenna insulators are not cracked or broken thereby enabling the delicate incoming waves to become grounded. The lead-in wire connection should be examined to see that corrosion has not set in due to faulty soldering, and further that the wire itself has not become grounded in any way in its path to the receiving set. If the ground wire has been attached to a water pipe this connection should be examined also and any faults corrected in order to insure a proper circuit from the antenna to the ground.

Next in importance are the vacuum tubes used in the set. Many a novice fails to get satisfactory results because the tubes are not operating at their full efficiency. The present-day tube employs a filament of special manufacture. When an excess voltage above the rated capacity of the tube is used, a sort of paralysis sets in and the tube then needs a little attention. A common way to correct this condition is to burn the filament of the tube for a period of time with the "B" battery disconnected. The length of time required for this operation depends entirely upon the condition of the tube when the fault is discovered.

For the tubes to give satisfactory results a good source of power is required which brings us to the subject of batteries.

In sets operating on dry cells great care should be taken to see that a proper voltage is maintained. Unless the filament of the tube is heated to the proper temperature the electronic emission is curtailed, with a consequent loss in efficiency. A sure check on dry batteries is the use of an inexpensive voltmeter. As soon as the voltage drops below the rated capacity of the tube it is well to restore the voltage by a new set of batteries, for worn or old batteries often are the cause of clicks and peculiar noises which mar the program.

When a storage battery is used for filament supply the problem is not so simple. All storage batteries need a certain amount of care. In fact with proper care a good storage battery should last five years or more, whereas if neglected the same battery may not last a year.

The first item in the care of the storage battery is to see that the level of the electrolyte is about one-quarter of an inch above the tops of the plates. This can be determined by unscrewing the plugs and looking into the battery. As storage batteries often emit some explosive hydrogen gas, care should be exercised not to use a match for the purpose of determining the level of the electrolyte. To maintain the proper level of the electrolyte, distilled water should be added at frequent intervals. Water should always be added to bring up the proper level of the electrolyte before the battery is placed on charge.

As its name indicates a storage battery is a storehouse for electricity. The current delivered to a battery brings about certain chemical changes in the electrolyte and these changes cease when the battery is fully charged. It is through this chemical change that one is able to determine the condition of the charge in the battery by testing its specific gravity. To test the specific gravity a hydrometer is used. A battery fully charged has a specific gravity between 1250 and 1300. As the battery is discharged the specific gravity decreases, due to chemical reaction, to 1100 or 1150 on the hydrometer.

The hydrometer reading, therefore, becomes the indicator of the condition of the battery. A voltmeter may also be used for the same purpose as the hydrometer. Each cell in the battery when fully charged should register 2.2 volts. When the voltage drops below 1.8 volts the battery needs recharging.

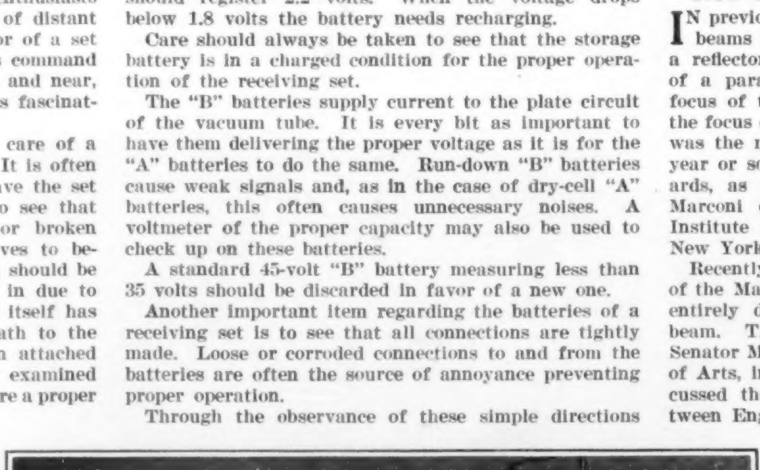
Care should always be taken to see that the storage battery is in a charged condition for the proper operation of the receiving set.

The "B" batteries supply current to the plate circuit of the vacuum tube. It is every bit as important to have them delivering the proper voltage as it is for the "A" batteries to do the same. Run-down "B" batteries cause weak signals and, as in the case of dry-cell "A" batteries, this often causes unnecessary noises. A voltmeter of the proper capacity may also be used to check up on these batteries.

A standard 45-volt "B" battery measuring less than 35 volts should be discarded in favor of a new one.

Another important item regarding the batteries of a receiving set is to see that all connections are tightly made. Loose or corroded connections to and from the batteries are often the source of annoyance preventing proper operation.

Through the observance of these simple directions beginners at radio can be sure that their sets are above many of the handicaps of poor reception. To the more experienced their observance may mean the restoration of the original good qualities that existed when their sets and equipment were new.



The much-talked-of Grindell Matthews, inventor of the "death ray," with his radio apparatus for testing voice vibrations before trying to photograph them on the motion-picture film that he used in his method for the production of talking movies

Static Gives Warning of Storms

A REAL use for static has been found by the New York Edison Company, the corporation that supplies New York City with electric light and power. The static has been made to predict, automatically, the approach of a thunderstorm.

These sudden thunderstorms are always feared by power-house superintendents. When one of them blows up the sky grows suddenly darker. This makes many people turn on the electric lights all at once. The result is a sudden demand on the power-house for more power; a demand that it is not always easy to meet. Advance warning of an approaching storm is a very necessary thing to the great city power companies and some of them have even gone so far as to provide their own weather service so that they would be sure to get news as long ahead as possible.

The plan worked out at the Waterside Station of the Edison Company is simpler. A radio antenna is erected and connected to a coherer, some relays and a bell. When there is static in the air from a distant storm this apparatus collects energy and every once in a while the bell rings. As the storm draws nearer to New York, the static grows stronger, more energy is picked up, and the warning bell rings at more frequent intervals.

Thus, when the engineer in charge of the power-house hears the static bell ringing more and more often he knows that a storm is on the way. He can fire up more boilers and get ready for it.

New Antenna for "Beam System" Radio

IN previous experiments on the production of directed beams of radio waves it has been customary to use a reflector composed of wires arranged in the shape of a parabola, the transmitter being located at the focus of this parabola, just as the lamp is placed at the focus of the parabolic mirror of a searchlight. This was the method used in the experiments conducted a year or so ago at the United States Bureau of Standards, as well as in the experiments which Senator Marconi demonstrated some months ago before the Institute of Radio Engineers and other societies in New York City.

Recently, however, Mr. C. S. Franklin, of the staff of the Marconi Company in England, has perfected an entirely different method of sending out a reflected beam. The new method was described recently by Senator Marconi in his lecture before the Royal Society of Arts, in London, the same lecture in which he discussed the recent successes with directed beams between England and Marconi's yacht, the "Eletra."

Mr. Franklin's system consists in using for the transmitting antenna proper a vertical wire grid, a good deal like a section of woven wire fence, but, of course, much larger in scale. Back of this is placed a precisely similar grid which acts as the transmitting mirror. Essentially what has been done is to substitute a plane mirror for the parabolic mirror of earlier experiments. It is necessary to feed the signal energy into the transmitting grid at several points in order to make sure that the wave in it is in phase with itself in all parts of the gridwork.

New Loud-Speakers for This Fall

TWO new loud-speakers have been announced for commercial introduction this fall. One of them comes from England and is the invention of Captain Round, a well-known engineer of the Marconi Company. The novelty about it is that it possesses a number of separate vibrating diaphragms, each of them tuned especially to a certain range of frequencies; which means, in music, a certain range of pitch. It is said that by this device all notes are given equally good reproduction. Notes that one diaphragm will not reproduce will get out through another one of the diaphragms.

The other new loud-speaker is a small edition of the double-cone instrument invented by Dr. Harvey Fletcher of the Western Electric Company and which was exhibited by him last winter before the New York Electrical Society. The two conical diaphragms of this speaker are placed face to face, with their points outward.

24-Tube Receiver Built to Listen to Mars

THE Technical Editor of the London radio weekly, *Popular Wireless*, built recently a receiver containing 24 vacuum tubes. There were 20 stages of radio-frequency amplification, detector and three stages of audio-frequency amplification. The object was to hear any signals that might be coming from Mars. As might have been expected, no such signals were received; but American broadcasting was heard on a small loop.

The hearing of anything at all on a receiver so complicated as this one must be considered no small achievement. Radio fans will await with interest information of just how the hook-up was put together.

The Heavens in November, 1924

Various Topics of Interest from a Month of Meetings

By Professor Henry Norris Russell, Ph.D.

THE PAST month has been marked by noteworthy scientific gatherings—first among them the great meeting of the British Association for the Advancement of Science, at Toronto. Much material of the greatest importance in physics was presented at this meeting, but relatively little in astronomy, except for Professor Eddington's account of his researches, of which we have already spoken in these columns last month. Mention may be made, however, of McLennan's proof that the green light given out by frozen nitrogen, under bombardment by cathode rays, does not contain any line in the position of the familiar, but inexplicable, line in the spectrum of the aurora. This disposes of a hypothesis which, though in some ways attractive, presented great difficulties, and leaves the way open for further research upon this elusive radiation.

The smaller meeting of the American Astronomical Society, at Dartmouth College, brought out more within the limited range of these columns. Many of the papers, of course, were almost entirely of technical interest—such as those on the small systematic corrections which must be applied to observations of various sorts; but the results, even of these, are of general interest, for it is only after such corrections have been applied that we can trust our results for the distances of the remote stars, which we derive from their motions. Dr. R. E. Wilson, of the Dudley Observatory, who has worked extensively along these lines, presented a discussion of the stars of spectral class (the so-called Wolf-Rayet stars), which are doubtless the hottest of all — concluding that they range over a wide interval of real brightness, from about 200 to 20,000 times the intensity of the sun.

Professor E. W. Brown told of new studies on spiral nebulæ, which show that it is possible that the particles composing the spiral arms may, after all, be moving under gravitational forces, and returning at intervals to the vicinity of the nucleus, provided that their orbits are so arranged that the outgoing particles cluster along the arms, while the returning ones are scattered more at random, and hence are less conspicuous. The mathematical details of the investigation will be awaited with much interest.

The Solar Atmosphere

St. John and Babcock, from Mount Wilson, gave details of their investigation of pressure in the sun's atmosphere. Almost all spectral lines are shifted toward the red when they are produced under pressure — and some more than others. By comparing suitably chosen groups of lines with large and small shifts, the pressure prevailing in the sun's atmosphere should be determinable. The idea is an old one; but as is too often the case, a multitude of difficulties beset its practical application—the most of them arising this time in the laboratory, where electrical conditions in the arc also shift the lines, and produce what is called "pole effect," because it differs at the positive and negative poles. When these troubles have been carefully eliminated, the authors find that group after group of lines agree in showing that the pressure in the sun's atmosphere is much less than in the earth's. The average result from more than 200 lines gives the pressure as 0.13 plus or minus 0.06 terrestrial atmosphere—far less than that at the top of Mount Everest. This completely confirms the conclusion derived from physical arguments, depending on ionization and kindred phenomena—which indicate a still lower pressure, too small to be measured by the pressure-shift method, but still consistent with the observations, within their own uncertainty. It is quite clear that all parts of the sun's visible atmosphere must be extremely tenuous.

The same authors find evidence that the high-level vapors, thousands of miles above the sun's surface, are slowly descending (a mile in three seconds being "slow" on the scale of solar phenomena) while those at the very lowest visible levels are ascending. A companion paper by St. John and Adams extends the same methods to several of the brighter stars, and shows that the pressures in the atmospheres of Sirius, Procyon and Arcturus are all low—in fact, two of the three values come out negative, though by no more than the error of observation. The visible regions of these stars, too, must be composed of gases of very low density. It appears also that the descending currents of cooler gas at a high level, and the ascending heated currents at a low level, move more rapidly in the hotter stars, which seems reasonable.

Planetary Temperatures

Perhaps the greatest general interest, however, attaches to certain measurements of the heat radiated by the planets. Pettit and Nicholson, at Mount Wilson, have applied their thermopile to Venus, when the planet appeared as a thin crescent; using a small heat detector which covered but a fraction of the planet's disk. Their curves show conclusive evidence that we get heat, not only from the bright side of the planet, but from the whole of the dark hemisphere too. The former is carried mainly by the reflected sunlight; the latter must represent heat stored by the planet's surface and re-radiated. When the reflected energy is separated (which can be done by interposing a screen of glass or water, transparent to it and opaque to the rest), it is found that the whole surface of the planet, on the sunlit and dark sides, is of about the same temperature—which comes out just below zero, on our familiar Fahrenheit scale. This seems surprisingly low but is not far from what might be expected for a planet which receives the sun's heat, at Venus' distance, on one side, reflects away 60 per cent of it (as Venus does), and gets rid of the rest by radiation from the whole surface.

Two important conclusions follow: first, that the planet can hardly keep the same face toward the sun—for if so, the dark side would almost surely be very cold indeed. Spectroscopic observations by Slipher and St. John show that the rotation must be slow—less than one revolution in ten of our days; but even a slow revolution, aided by the transport of warmer air by the wind, would keep the dark side from cooling very far. Second, if the temperature at the visible surface is so low, the absence of any considerable amount of water vapor in the atmosphere above it is consistent with the existence of water (or perhaps ice) upon the planet's surface. The new data still appear to support the view that the visible surface of Venus consists of clouds, like our high cirrus clouds, composed of fine ice-crystals; but further studies, which are doubtless in progress, will be eagerly awaited.

While Venus thus appears to be cold, Mars, according to a preliminary communication from Coblentz and Lampland at the Lowell Observatory, is warmer than previously supposed. The methods of observation are the same as for Venus, and should lead, when the year's work is finished, to reliable values. The observers wisely refrain from mentioning any figures for the temperature till their work is completed.

At 11 o'clock: Nov. 7.
At 10½ o'clock: Nov. 14.
At 10 o'clock: Nov. 22.

At 9 o'clock: Dec. 7.
At 8½ o'clock: Dec. 15.
At 8 o'clock: Dec. 23.

At 9½ o'clock: November 30.

NIGHT SKY: NOVEMBER AND DECEMBER

The Heavens

The winter constellations have returned to our sight in all their glory. Orion blazes in the southeast, with Taurus above and Canis Major below. To the left of these are Canis Minor, Gemini and Auriga; with Perseus above the last and almost overhead. The two Bears and the Dragon are all low in the north, with Cassiopeia and Cepheus above them. Cygnus and Lyra are low in the northwest, Pegasus high in the west, and Andromeda in the zenith. Aquarius and the Southern Fish are in the southwest, and Cetus and Eridanus occupy the great dull region in the south.

The Planets

Mercury is an evening star all this month—at first too near the sun to be observed, and so far south, even at the last, that he sets at 5:30 P. M., and is very hard to see.

Venus is a morning star in Virgo, rising at 3:10 A. M. on the 1st, and 4:00 A. M. on the 31st. She is very conspicuous.

Mars is rapidly losing his glory, and is twice as far away as he was in August, when the editorial telephone was kept busy answering inquirers who wanted to know his distance and other things about him. But he is still brighter than any other star save Sirius, and is the principal adornment of the constellation Aquarius.

Jupiter is an evening star, setting at 7:00 P. M. on the 1st, and lost in the twilight before the month closes. Saturn is a morning star, but too near the sun to be seen till the end of the month, when he rises at 4:00 A. M. Uranus is in Pisces and observable all the evening. On the 27th he is 16 minutes north of Mars, and may be seen with a good glass, in spite of the glare of the larger planet. Neptune is in Leo and comes into quadrature west of the sun on the 15th.

The moon is in her first quarter at 5 P. M. on the 3d, full at 7 A. M. on the 11th, in her last quarter at 1 P. M. on the 19th, and new at noon on the 26th. She is nearest the earth on the 27th, and furthest away on the 14th. During the month she passes near Mars on the 5th, Uranus on the 6th, Neptune on the 19th, Venus on the 23d, Saturn on the 24th, and Mercury and Jupiter, close together, on the 27th. Neptune is occulted at his conjunction, but the planet is so faint that his disappearance would be very hard to see, even with the largest telescope. Mars is also occulted on the 5th, but the phenomenon is visible in Europe and not here.

Astronomy and Radio

AMATEUR astronomers who are also interested in radio are invited to participate as special observers in the SCIENTIFIC AMERICAN'S *investigation of the solar eclipse next January.*

Read the notice and description of the test, published on another page of this issue and send the information asked for to the Eclipse Editor.

Recently Patented Inventions

As a convenience to our readers, we will supply copies of any patents listed herein for 15 cents each. The official printed copies of patents include ***complete descriptions and*** *drawings of the inventions disclosed. State the patent number to insure receipt of the desired patent copy.*

Pertaining to Apparel

INVISIBLE CLASP FOR GARMENTS—Of the hook-and-eye type, having means for securing the members to the garment. Patent 1496706. M. L. and P. L. Friedman, 37½ St. Mark's Place, New York, N. Y.

NECKBAND FOR SHIRTS—Having means at one end for adjusting the size of the same. Patent 1496380. J. H. Ryan, Box 514, McAdoo, Pa.

REDUCING BRASSIERE — Which induces copious perspiration, thereby loss of excess flesh without harmful effect. Patent 1496,-255. B. Cervelli, 49 Glorey St., San Francisco, Cal.

ADJUSTABLE HAT LINING — With means for regulating the head size of ladies' hats. Patent 1497625. A. Wenger, 171 Van Buren St., Brooklyn, N. Y.

ARCH SUPPORT—Adapted to be secured to shoe soles beneath the arch, and embodying means to brace the sole. Patent 1497598. E. Seavey, 359 Pearl St., New York, N. Y.

NECKTIE STRETCHER—For the purpose of removing wrinkles resulting from the tying operations. Patent 1497525. I. Macowsky, 1786 Topping Ave., New York, N. Y.

COLLAR—So constructed that the possibility of the material about the buttonholes, or folding line, tearing is reduced to a minimum. Patent 1498496. M. Wald, 575 W. 159th St., New York, N. Y.

CORSET—Of the front lace type, having an inner retainer to hold the corset while lacing the same. Patent 1502481. S. J. Newman and R. E. Dodge, c/o J. Newman & Sons, Inc., New Haven, Conn.

SHOE TONGUE—Having means whereby it may be retained in place between the edge portion of the shoe upper. Patent 1502429. C. M. Haddox, 405½ Capitol St., Charleston, W. Va.

HOSE SUPPORTER—Which by distributing the strain on the hose, will prevent frequent tearing. Patent 1503988. W. D. Furey, 100 W. 27th St., Baltimore, Md.

GARMENT—In the nature of a coat, so formed that the sleeves may act in the usual manner, or may be positioned out of the way presenting substantially a vest. Patent 1505053. D. Millhauser, 1139 E. 13th St., Brooklyn, N. Y.

RUBBER HEEL—Which may be applied in a single piece, or in sections, making it unnecessary to renew the entire heel if a portion becomes worn. Patent 1505038. C. W. Lavers, c/o Double Wear Interchangeable Heel Co., 37 Lakeville St., Halifax, N. S., Canada.

COMBINED COAT AND MUFFLER—Having the usual appearance of an overcoat but having means readily adjustable to act as a muffler. Patent 1504935. L. Buchalter, c/o Lester M. Friedman, Woolworth Bldg., Broadway, New York, N. Y.

Electrical Devices

HEATER—Including an electric heating element adapted to heat a fluid during its passage through the heater. Patent 1495,-658. R. L. Wilkinson, 1024 55th St., Oakland, Cal.

MULTIPLE FUSE PLUG — So constructed that when one fuse blows out another will replace it. Patent 1495867. J. M. Neidig, 814 N. 6th St., Harrisburg, Pa.

CLAMP—For securely attaching several electrical branch conductors to the main conductor. Patent 1496603. M. R. Rothenberger, c/o Franz Grove, 180 St. Mark's Ave., Brooklyn, N. Y.

LAMP CORD CONNECTER—Of the type employed to secure the pull chain of a lamp socket to an ornamental cord. Patent 1496,-147. J. J. Cook, 1301 So. Michigan Ave., Chicago, Ill.

RADIOSWITCH—Provided with means for introducing any desired number of vacuum tubes into radio-receiving circuits. Patent 1497586. B. W. Prall, 160 College Ave., W. New Brighton, S. I., N. Y.

ELECTRIC SOLDERING IRON—Wherein the handle is effectively insulated from the heat produced by the heating element. Patent 1497628. E. Young, c/o Adroit Tool Co., 14 Front St., New York, N. Y.

COVER FOR ELECTRIC SWITCH KEYS—Which may be readily applied, and may be made to match the appearance and finish of the lamp. Patent 1502582. C. E. Neidig, 21 So. 2d St., Harrisburg, Pa.

ELECTRIC PERMUTATION LOCK — Which may be employed with any electric circuit, but designed for use with the ignition system of motor vehicles. Patent 1503403. H. D. Wethling, 318 Main St., Orange, N. J.

INSULATED COUPLING FOR ELECTRIC FIXTURES—Of minimum length, but substantially as strong as an all-metal coupling. Patent 1502938. F. L. Butler, 740 E. 36th St., Chicago, Ill.

PHOTOGALVANOGRAPH—A portable device whereby photographic records can be automatically obtained of galvanometric deflections, an electrical testing device forming part of the apparatus. Patent 1503401. D. Wechsler, 1291 Madison Ave., New York, N. Y.

MEANS FOR PRODUCING ELECTRIC OSCILLATIONS BY AN ELECTRIC ARC—With the aid of a self-induction connected in series with the arc and made very large. Patent 1503,-324. R. Herzog, c/o F. Warschauer, 111 Gitschiner St., Berlin, S. W. 61, Germany.

BATTERY CONSTRUCTION—Whereby batteries may be kept for an indefinite time without deterioration. Patent 1503380. D. Rosen and C. Shickerling, 113 Highland Ave., Jersey City, N. J.

PLUG ATTACHMENT—Wherein a plurality of independent feed wires may be connected to a single socket. Patent 1503306. F. Dominick, 3495 Broadway, New York, N. Y.

ELECTRODE HOLDER—For use in electric welding, holding the electrode so that the same may be conveniently attached to or removed from the holder. Patent 1503541. H. T. Lintott and H. J. Charbonneau, Pine Terrace, So. San Francisco, Cal.

DYNAMIC BRAKE FOR ALTERNATING-CURRENT MOTORS—Particularly applicable to motors used for electric elevators and hoists. Patent 1504224. R. H. Fisher, 6024 Bryn Mawr Ave., Chicago, Ill.

PLUG CONNECTION—In which the plug is provided with spring members, permitting instant contact by a thrust into the socket. Patent 1504823. A. H. Kline, 3340 Berteau Ave., Chicago, Ill.

Of Interest to Farmers

POISON APPLIER—For applying poison to cotton or other growing crops, to destroy boll weevil or other insects. Patent 1502539. F. G. Asbill, Ridge Springs, S. C.

PEANUT DIGGER—For cutting the vines within and above the soil, and adjustable to the character of ground being traveled. Patent 1502795. J. E. Parker, Box 577, Norfolk, Va.

CLEAN-COW BAR—Adapted for use in dairy barns to prevent cows from excavating in their stalls. Patent 1503039. E. J. Franklin, Rainier, Ore.

CONVEYER FOR PEANUT DIGGERS—For carrying the vines from the plow, shaking out the dirt, and discharging them ready to be stacked. Patent 1502796. J. E. Parker, Box 577, Norfolk, Va.

POISON DISTRIBUTOR — Which contacts with the cotton plant foliage and applies the poison thereto for the destruction of boll weevil. Patent 1504818. J. P. Fullilove, 1825 Fairfield Ave., Shreveport, La.

Of General Interest

KNIFE SUPPORT—Whereby the blade of a table knife will be held out of contact with the table linen. Patent 1491623. W. Pitchur, 62 Hoyt St., Brooklyn, N. Y.

FUR BUTTON—In which the strains on the fur are taken up by a rigid core on the button. Patent 1492475. M. and H. R. Lichtenstein, c/o Lichtenstein Bros., 365 Seventh Ave., New York, N. Y.

MUCILAGE RECEPTACLE—For holding a mucilage spreader, when the same is not in use. Patent 1491643. C. M. Tanenbaum, Coconut Grove, Fla.

FIRE ESCAPE—Provided with means for lowering an individual from any elevation and controlling the speed of descent. Patent 1500943. J. D. Jolkovski, Room 917, Woolworth Bldg., New York.

EGG-CRATE UNPACKING AND REPACKING APPARATUS—By means of which time, labor and the breakage of eggs is reduced to a minimum. Patent 1500939. D. A. Howell, 51 Chambers St., New York, N. Y.

POCKET FOR SHOWER-BATH CURTAINS—For holding soap, sponges, wash cloths and similar articles. Patent 1500991. K. Heitler, 221 4th Ave., New York, N. Y.

SHOE-POLISHING BENCH—With means for holding a shoe in position for an operator to polish the same. Patent 1500989. C. P. Hadley, 45 Thomas St., Newark, N. J.

SAFETY RAZOR—Including a handle capable of utilizing various forms of safety razor blades as now manufactured. Patent 1500,-165. T. Thorpe, c/o J. F. Malloy, Room 804 Ford Bldg., Wilmington, Del.

BED CONSTRUCTION—Whereby the detachment of the head and side rails of a bed can be more easily effected. Patent 1500956. A. Mestas, c/o Graham, Henkley & Co., 133 Front St., New York, N. Y.

TRAP—Formed with a tilting plate adapted to dump a mouse or rat into a container. Patent 1500525. H. Pierini, c/o McMahon Land Co., Opera House Bldg., Greenville, Miss.

INSECTICIDE CONTAINER AND DISTRIBUTOR—In which the original container may be utilized to eject the contents in spray form. Patent 1500514. A. L. Milligan, 201 Kiser Bldg., Atlanta, Ga.

EGG BOILER — Adapted to automatically lift the eggs from the water at a predetermined number of minutes. Patent 1500958. A. C. Parodi, 44½ Cottage St., Jersey City Heights, N. J.

METHOD OF MAKING SHOES—For children, by separately sewing an insole and an outsole, with a coating of cement, to the shoe uppers. Patent 1500527. A. H. Prenzel, Halifax, Pa.

SAFETY RAZOR—In which the handle forms a continuation of the guard supporting the blade. Patent 1500953. M. L. Masters, Mount Ulla, N. C.

COMBINATION PENCIL CASE AND STYLUS—The case, or point protector, having embedded in the tip a stylus. Patent 1500426. S. H. Townsend, Bucklin, Mo.

SELF-ADJUSTING ARCH SUPPORT—Capable of adjusting itself to the peculiar contour of the patient's foot. Patent 1488561. I. Sommerfield, 5225 Glenwood Ave., Chicago, Ill.

SMOKING PIPE—That may be smoked with comfort outdoors regardless of weather, and that eliminates all danger of fire. Patent 1501370. V. K. Ramsey, R. F. D. No. 1, Box 481, Santa Rosa, Calif.

PENCIL SHARPENER—Whereby the pencil is sharpened by rotary and oscillatory movements. Patent 1501792. S. K. Mathews, 105 Grand St., Albany, N. Y.

METALLIC PENCIL—Formed of lead alloy, which will write clearly and may be readily sharpened. Patent 1501745. F. Carroll, 6 Convent Ave., Yonkers, N. Y.

CALENDAR—Having a frame of attractive appearance, and forming a perpetual calendar. Patent 1501803. W. S. Orth, Dunkirk, Ohio.

COLLAPSIBLE BATHTUB—Adapted to be placed over a regular bathtub for the convenience of washing an infant. Patent 1501,-833. J. S. Amsel, 321 Montgomery St., Brooklyn, N. Y.

HAT SUPPORTING HOOK—Capable of being carried upon the person, and adapted for hanging a hat or coat in public places. Patent 1501807. O. Petschel, 430 Jefferson Ave., Brooklyn, N. Y.

PAPER CLIP—Formed from an elongated strip of resilient material with a plurality of prongs for properly penetrating the paper. Patent 1502623. J. Fritz, 102 Arnold St., New Bedford, Mass.

QUOIN—Which will not become accidentally loosened even when appreciably jarred. Patent 1501753. J. J. Curtis, 146 W. 10th St., New York, N. Y.

MARINE LIFE-SAVING APPLIANCE — Constructed to prevent the cork blocks striking the wearer's head when jumping into the sea. Patent 1502543. M. D. Boddy, 12 Dartmouth Place, Blackheath, London, S. E. 10, England.

CARTON—Which effectively seals the contents, and excludes dirt and vermin after the package has been opened. Patent 1502,-606. F. J. Whelan, 273 Maple St., Brooklyn, N. Y.

BABY-BLANKET HARNESS — Which presents a proper covering for the child and prevents the accidental removal of the same. Patent 1502608. H. B. Young, 3163 Sedgwick Ave., Bronx, N. Y.

COVERED SPRING STRUCTURE — Having means for holding the springs under partial compression, and for insulating the convolutions from each other. Patent 1502510. S. S. Marcus and S. Krakauer, c/o Spring Products Corp., 2505 3d Ave., New York, N. Y.

CLEANING DEVICE—By means of which the hand of the operator will not become soiled through contact with the shoe, or other article being cleaned. Patent 1502798. F. I. Phoenix and A. H. Behrman, c/o F. I. Phoenix, Hotel Huntley, Reedsburg, Wis.

SERVER—In which a complete course dinner of portions thereof may be kept warm and in proper condition. Patent 1503363. R. A. Hall, 4681 Hamilton Ave., Cincinnati, Ohio.

HAIRDRESSING APPLIANCE—For carrying out the so-called "permanent" hair waving, without the risk of damaging the hair by overheating. Patent 1503295. A. H. Bongers, 7 The Exchange, Muswell Hill, London, N. 10, England.

GOVERNOR VALVE—Capable of automatic action for constantly maintaining a given pressure in a pipe-line. Patent 1503357. W. B. Ensign, 2350 Coeston Ave., Bayonne, N. J.

Hardware and Tools

FASTENING DEVICE—Consisting of a pair of metal shanks for retaining storm windows or screens in place. Patent 1498959. I. G. French, 24 Winter St., Orange, Mass.

PENCIL SHARPENER—Presenting an ample cutting surface yet protecting the lead against breakage. Patent 1500056. C. A. Conover, 53 Water St., Newburgh, N. Y.

STUD DRIVER—For use in driving studs into castings and the like. Patent 1499701. L. Skeel, c/o McCrosky Tool Co., Meadville, Pa.

NAIL—Adapted to form a concealed fastener for pictures, wall decorations and the like. Patent 1499826. C. H. Kassabaum, Atchison, Kan.

SCREW DRIVER—With means for gripping and holding the screw to the tip of the screw driver. Patent 1499491. P. Weissbeck and L. Tibbals, 519 Spence St., Kansas City, Mo.

KNIFE—Of that type of construction in which the blades are detachable from the handle. Patent 1500402. E. Lewis, 425 So. 16th St., Terre Haute, Ind.

RAKE—With means for adjusting the angle of the head with relation to the handle. Patent 1501006. B. E. Leas, Luverne, Minn.

MECHANIC'S INSTRUMENT—Constructed to be set at different positions and used as a square, a miter, a bevel or a rule. Patent 1501837. C. F. Benjamin, 24 Hill St., Milford, Conn.

RAZOR BLADE HOLDER—Whereby a safety razor blade may be gripped for the purpose of sharpening it. Patent 1501783. P. Kilimnik, 25 Fulton Ave., Middle Village, L. I., N. Y.

SHADE, CURTAIN OR AWNING ROLLER STOP—In the nature of an attachment to limit the rotation of the roller. Patent 1502197. G. D. Hill, Apt. 28, The Courtland, Portsmouth, Va.

BLADE HOLDER—Adapted for use with safety razor blades for various purposes. Patent 1502627. E. W. Hammond, 10 W. 23d St., New York, N. Y.

UNIVERSAL CIRCULAR ARC TEMPLATE—Having an adjustable means for accurately centering a pen or pencil which describes an arc. Patent 1502277. T. Speiden, P. O. Box 252, Danville, Va.

FRAME FOR BEDS—Which may be quickly assembled, and will form a corner lock connection between the side and end rails. Patent 1502587. L. J. Priebatsch, Brookhaven, Miss.

MAGAZINE ROTARY DRILL BIT—Having no sharp cutting edges and being adapted for disintegrating rock and other substances encountered. Patent 1502851. G. W. Gale, 909 11th St., Greeley, Colo.

UNDERREAMER—The cutting bits being so mounted as to be held in contracted position during inserting the reamer. Patent 1503377. J. W. Pippin, c/o Keaton, Wells & Johnson, Attys., Oklahoma City, Okla.

HAMMER—Having a head of two separable sections, each of which may be adapted for different operations. Patent 1501095. G. F. Brock, 1015 Summit St., Hancock, Mich.

PISTON-RING TOOL—For contracting a piston ring to facilitate its application to a piston. Patent 1505017. H. A. G. Fornelius, 12 Spring St., Clifton, N. J.

Heating and Lighting

OIL BURNER—Which automatically controls the flow of oil from a source of supply to the burner. Patent 1499306. F. X. Mantsion, 2110 So. Broad St., Philadelphia, Penn.

DIRECT-FIRED TUNNEL FURNACE—Constructed for treating a reactive material with a gas, while protecting it from the furnace flame. Patent 1499042. F. Von Bichowsky, 1412 San Fernando Blvd., Glendale, Cal.

SAWDUST GRATE BAR—Wherein the supporting ribs do not interfere with the passage of air, in burning sawdust. Patent 1501618. A. J. Parsons, Tenn and Ann Sts. and Mich. Ave., Mobile, Ala.

STEAM BLOWER—For cleaning ashes or cinders from the combustion chamber of a furnace or stationary boiler. Patent 1501,-090. H. McC. Barr and G. Edgar, c/o International Blower Co., Box 1070, Pensacola, Fla.

HEATING SYSTEM—Providing air heating means, and conducting air under control into and downwardly through the chimney. Patent 1504941. W. A. Collver, 240 Hall Ave., Marshfield, Ore.

BOILER—For steam or hot water heating so arranged as to facilitate the disassemblage for renewal of parts. Patent 1504924. R. Anderson, Brooks, Alberta, Canada.

Machines and Mechanical Devices

CLOTH ROLLING MACHINE—Constructed to fold and roll, and at the same time measure the amount of cloth rolled. Patent 1499254. A. Rocklin, 31 Washington St., Gloversville, N. Y.

SHUTTLE—Designed for silk weaving machines and having means for easily substituting a new pin for a worn one. Patent 1499256. T. H. Scott, R. D. No. 3, Coatesville, Pa.

COMBINED SPRAY AND PAINTBRUSH—In which a plurality of nozzles are used for applying the spray, which is adjustable with respect to the brushes. Patent 1498759. J. G. Schmidt, 1611½ Center St., Milwaukee, Wis.

PHONOGRAPH ATTACHMENT—For increasing the capacity of records of ordinary size. Patent 1498850. F. C. Meyer, 4256 Washington St., Gary, Ind.

PROTECTOR AND SMASH-PREVENTING MECHANISM FOR LOOMS—Which will stop the loom immediately upon the happening of any false operation of the shuttle. Patent 1498847. J. F. Lehman and J. W. McDaniel, 2527 Besmer Bldg., Fairview, Birmingham, Ala.

COLLAPSIBLE ELEVATOR—For elevating persons and objects to various distances for any desired period of time. Patent 1498813. H. G. Sankela and C. F. Stegmeier, c/o Preston-Shagger Milling Co., Waitsburg, Wash.

METHOD OF AND APPARATUS FOR PREPARING MOLDS FOR CASTING—Particularly adapted for casting porcelain or metal teeth as used in dentistry. Patent 1499207. R. L. Folsom, c/o Jones, Pomeroy & Jones, Carlson Bldg., Pocatella, Ida.

GREASE-CUP PROTECTOR—Which is readily applied to protect the exposed threads of a grease cup against dirt. Patent 1499,-288. D. A. Buell, address Geo. D. Buell, Hartland, Mich.

MOP WRINGER—In which the water is squeezed out of the mop by presser plates, easily operated. Patent 1500058. P. C. Courtemanche, 52 Central St., Claremont, N. H.

TOMATO CORER—For trimming and removing the stem preparatory to cooking or canning. Patent 1500085. J. Q. Leavitt, 2751 Washington Ave., Ogden, Utah.

WELL-BORING TOOL—Adapted for enlarging or reaming a bore or well opening. Patent 1500001. W. J. Rogers, 215 W. 13th St., Houston Heights, Houston, Texas.

METHOD AND APPARATUS FOR PRODUCING MOVING PICTURES AND SOUND WAVES AT THE SAME TIME—By the simultaneous taking and delivery of light pictures and sound waves by a photographic process. Patent 1500037. E. Reisz, c/o Fehlert, Loubier, Harmsen & Meissener, S. W. 61 Belle, Allianceplatz 17, Berlin, Germany.

LATHE—Designed for metal working such as the turning and boring of castings used in hat manufacture. Patent 1499707. W. C. Thatcher, 1509 John St., Govans, Baltimore, Md.

SODA WATER FOUNTAIN—In which the beverages are automatically mixed and dispensed upon the deposit of proper coins. Patent 1499466. A. S. Mandel, 208 Eldridge St., c/o J. Rothberg, New York, N. Y.

ORE CONCENTRATOR—For washing gold and platinum from placer sand as originally found. Patent 1499471. L. H. Peck and W. A. Olson, Good Springs, Nevada.

PUMPING EQUIPMENT FOR WELLS—Having means to prevent floating sand from settling on the packers and wearing the same. Patent 1499690. W. B. Pine and I. V. Martin, Box 525, Okmulgee, Okla.

AIR PAN—For use in the flotation process in the separation of minerals and waste. Patent 1499496. E. H. Anderson, R. F. D. Box 12, Magna, Utah.

PAVEMENT MARKER—Adapted for marking streets, parking places and the like for the purpose of providing safety zones. Patent 1498851. J. T. Narbett, 906 Macdonald Ave., Richmond, Cal.

TWISTER—Which will keep the strands of yarn divided while twisting them into a thread. Patent 1500296. J. S. Bachman, c/o Anchor Duck Mills, Rome, Ga.

TIE-ROD TIGHTENER AND PULLER FOR CONCRETE FORMS—For use in connection with the construction of concrete walls. Patent 1500204. A. H. Richard, 502 Commercial Bank Bldg., Alexandria, La.

LONG-CHAIN-WARP-TREATING APPARATUS—Including warp boiling, dyeing, washing and drying, arranged for the passage of the warp through a single run. Patent 1500,-298. H. M. Chase and G. M. Robertson, c/o Riverside and Dan River Cotton Mills, Danville, Va.

VALVE—Which will prevent the escape of steam when in open position. Patent 1500,-775. C. Sonner, address P. Berdar, Chief Engr. S.S. "Florida," A. N. S. S. Co., Pier 28, San Francisco, Cal.

CHANGE MAKING DEVICE—Having a register actuated by the purchase keys, preserving a record of the total of the purchased amounts. Patent 1500262. A. Papoulias, Steubenville, Ohio.

SAFETY CONTROL DEVICE—Adapted to be automatically applied to a hoisting mechanism. Patent 1500403. H. H. Logan, 1765 Winnemac Ave., Chicago, Ill.

SPINDLE STOP-MOTION ATTACHMENT FOR SPINNING MACHINES—Which may be mounted on any spindle rail to stop the spindle without interfering with adjacent spindles. Patent 1500982. E. C. Cushman, 79 Bank St., Room 8, New London, Conn.

POWER-PRESS GUARD—Which is operated by mechanism in the form of a single pedal. Patent 1500960. E. C. Regan, 124 Allen Place, Hartford, Conn.

SKIN MARKING—Adapted to hold marking members which may be conveniently heated for the marking operation. Patent 1500987. O. H. Foss, 18 Hennepin Ave., Minneapolis, Minn.

EMBOSSING MACHINE—For charing wood in such manner as to give antique grain and wood bark effects. Patent 1500961. E. H. Reiber, West Webster, N. Y.

PUSHER FOR KNITTING MACHINES—Which will act to cause the pins to be pushed more readily and to accurately function. Patent 1500968. G. C. L. Tisch, 452 Spring St., Elizabeth, N. J.

WARP DYEING APPARATUS—Wherein the dye is maintained in approximately full strength with uniform results. Patent 1500,-299. H. M. Chase and G. W. Robertson, Riverside and Dan River Cotton Mills, Danville, Va.

CIGARETTE MAKING DEVICE—Adapted to make cigarettes of uniform thickness throughout their length, automatically feeding the paper to the tobacco. Patent 1501,-313. J. E. Crotty, 4816 Kenmore Ave., Chicago, Ill.

CHOKE DETECTOR—For folding machines and other machines used in the printing and allied trades. Patent 1501808. J. Prush and A. B. Lanigan, 4909 Ft. Hamilton Parkway, Brooklyn, N. Y.

CIRCULATING PUMP—Designed to be employed in connection with the lubricating system of an automobile or other machines. Patent 1501758. M. A. Drees, 432 15th St., Milwaukee, Wis.

CIGAR PERFORATING DEVICE—To be used in lieu of cutting or biting the cigar end, thus obtaining a more perfect draft. Patent 1501811. C. Schley, 247 Pierre Ave., Garfield, N. J.

SHOE-TREE-FORMING MACHINE—Including mechanism by which a single operator may handle any desired number of members to be formed. Patent 1502485. O. Olson, 551 82d St., Brooklyn, N. Y.

APPARATUS FOR AND METHOD OF CEMENTING OIL WELL CASINGS—By means of which a cementing mixture can be ejected to seal the formation seat against the seepage of water. Patent 1502179. E. V. Crowell, Box 1479, Sta. "C," Los Angeles, Cal.

HIGH-SPEED REDUCTION GEARING—Which will eliminate errors of alinement between pinion and gear teeth due to wear of bearings, etc. Patent 1502175. C. F. Clapham, 1822 St. Paul St., Baltimore, Md.

VALVE GRINDING DEVICE—More particularly for grinding what are known as overhead valves. Patent 1502015. M. S. Bishir, Canyon, Texas.

HINGED SPIDER—That may be clamped about a pipe casing to suspend the same while repairs or other emergencies are dealt with. Patent 1502628. F. L. Hanna, c/o T. R. Ermey, White Eagle Oil Co., Box 1116, Wichita, Kan.

MAP MOUNTING AND MEANS FOR OPERATING IT—Whereby maps of all kinds may be readily observed, and a course between two points quickly determined. Patent 1502536. H. F. Ammidown, 20 Chestnut St., Southbridge, Mass.

OPERATING MEANS FOR CURTAINS—Which when associated with a curtain or portiere, will be practically invisible. Patent 1502,-586. J. Pilny and W. Kuehn, 245 Westervelt Ave., New Brighton, S. I., N. Y.

ALINING JIG—By means of which the inaccuracy between a piston and its connecting rod may be determined to the thousandth of an inch. Patent 1502542. N. A. Best, 717 Midland Ave., Midland, Mich.

COMBINED SHOVELING AND LOADING DEVICE—With means for loosening and conveying dynamited coal to a mine car or the like. Patent 1502143. E. T. Kell, 1207 E. Main St., Benton, Ill.

PAPER CUTTING MACHINE—With means for raising or lowering the knife to position where it may be secured or removed from the knife bar. Patent 1503408. H. S. Williams, 271 Bainbridge St., Brooklyn, N. Y.

Medical Device

HYPODERMIC SYRINGE—In which the needle aids in preventing the escape and contamination of the aseptic fluid when not in use. Patent 1499508. H. C. Deane, Shoshone, Idaho.

THERMOMETER AND CASING THEREFOR—With means for supporting a clinical thermometer out of contact with a table or other support or preventing its rolling. Patent 1501801. C. Nurnberg, 397 Bridge St., Brooklyn, N. Y.

NASAL DOUCHE—For treating abnormal conditions of the nasal passages by a simple and conveniently manipulated device. Patent 1502163. W. P. Sprague, San Rafael, Cal.

CONTAINER FOR HYPODERMIC NEEDLES—In which a needle may be sterilized, sealed, and held in a sterilized condition until wanted. Patent 1501324. L. Eisele, c/o Eisele & Co., Nashville, Tenn.

ORTHODONTIC APPLIANCE—Readily disposed in the mouth for the purpose of maintaining the teeth in proper alinement. Patent 1504942. T. McL. Comegys, P. O. Box 780, Shreveport, La.

ANCHOR FOR LOWER DENTURES—By means causing the anchors to cling to the lower side walls of the mouth without preventing freedom of movement. Patent 1504904. T. Roxbury, 29 W. 34th St., New York, N. Y.

Prime Movers and Their Accessories

AUXILIARY AIR INTAKE FOR INTERNAL-COMBUSTION ENGINES—Which may be positioned from the engine and manually controlled at any time. Patent 1500031. J. Phillips, 470 Convent Ave., New York, N. Y.

ENGINE TIME REGISTER—Among its objects being to simplify engine timing, especially for the repairman. Patent 1499255. J. F. Sauer, c/o Sauer Bros., 4th and Main Sts., Chico, Cal.

PISTON—Provided with means whereby a soft packing may be employed for internal combustion engines or the like. Patent 1498835. J. W. Calta, Platte, S. D.

OIL SUMP SCREEN—For straining the lubricating oil before it is introduced to the oil-circulating pump of an internal combustion motor. Patent 1501804. V. W. Page, c/o Victor Page Motor Corp., Melrose Ave., Stamford, Conn.

IGNITION MEANS FOR INTERNAL COMBUSTION ENGINES—Which will eliminate the necessity of an electric ignition system, one cylinder firing another in order. Patent 1501505. P. Walters, 49 Cedar St., Dobbs Ferry, N. Y.

ROTARY ENGINE—Which may be run by either steam or air. Patent 1504654. H. O. Taylor and L. C. Brown, Sasakiva, Okla.

Railways and Their Accessories

CAR-CONTROLLING DEVICE—For facilitating the removal of loaded cars on trucks from a dry kiln or the like. Patent 1499638. L. A. Brake, 1007 W. Main St., Crawfordsville, Ind.

BRAKING MECHANISM—Especially adapted for use with log skidders on steep grades. Patent 1499258. S. H. Smith, c/o Naul & Yawn, Attys., Brookhaven, Miss.

BRAKE—So placed upon a railroad car that it will eliminate danger to employees when operating the brake. Patent 1500717. W. J. Quinn, c/o J. J. Moran, Atty., Pottsville, Pa.

CAR TRUCK—Having control mechanism whereby parts of a truck may be drawn into and out of operation. Patent 1501744. S. B. Brilhart, 370 W. 120th St., New York, N. Y.

LOCOMOTIVE DRIFTING VALVE—Providing for the automatic controlled supply of saturated steam continuously during drifting. Patent 1502283. E. B. Whelan, 1025 So. 10th St., Omaha, Neb.

GRAIN CAR DOOR—The sections of which may be readily removed without damaging the same when unloading the car. Patent 1503173. P. E. Tufts, 811 Canada Bldg., Saskatchewan, Canada.

AIR BRAKE—For use in conjunction with the customary brake equipment employed upon railway cars. Patent 1504536. G. A. Anderson, Santa Rita, N. M.

COMBINED TIE AND RAIL FASTENER—For releasably holding a rail without the use of spikes or similar fastening devices. Patent 1504262. H. Z. Morgan, West End Station, Pine Bluff, Ark.

Pertaining to Recreation

GAME APPARATUS—Adapted for playing a racing game, more particularly simulating a foot race. Patent 1500983. J. H. Deen, 2 Marble Hill Ave., Bronx, N. Y.

BASEBALL GAME BOARD—Whereby the position of players and the act of base running can be efficiently produced on a game-board. Patent 1502619. M. M. Doob, 220 5th Ave., New York, N. Y.

GAME—In which tokens are manually slidden over a board, the sliding movement being controlled by the player's skill. Patent 1502607. G. Wright, 1601 Hanover St., Aurora, Colo.

GAME—Comprising a board on which a mock game of baseball or football may be played by one or more people. Patent 1503294. W. G. Bishop, 2201 Classon Blvd., Oklahoma City, Okla.

BASEBALL COVER—Which will eliminate the rough and raised edges where the two

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leathers are sewed together. Patent 1502,-784. B. Kennedy, c/o Ken Wel Sporting Goods Co., Gloversville, N. Y.

EDUCATIONAL GAME—Suited for the instructing of children to spell, and to recognize objects. Patent 1505010. J. H. Deen, 2 Marble Hill Ave., New York, N. Y.

TOY CONSTRUCTOR—In the nature of a card-house-constructor clip, formed of a unitary piece of material. Patent 1505034. I. Kussner, 923 Fox St., Bronx, N. Y.

Pertaining to Vehicles

PROTECTIVE DEVICE FOR PNEUMATIC-TIRE VALVES—Which facilitates the removal of the dust caps and felly-engaging clamping member, from the valve stem. Patent 1499,-246. G. W. Oakes, c/o Pittsburg Plate Glass Co., Crystal City, Mo.

METHOD AND APPARATUS FOR SIGNALING—By which any change in direction or speed can be indicated by manipulating the vehicle lights. Patent 1499236. L. McMillan, 2508 First St., San Diego, Cal.

JACK—Which may be moved to operative position by power transmitted from the automobile. Patent 1499280. H. A. Alheit, 149 Audubon Rd., Boston, Mass.

COLLAPSIBLE CORE FOR PNEUMATIC TIRES—So constructed that the sliding connection may be readily broken but is not liable to accidental disconnection. Patent 1499297. P. De Mattia, c/o Munn, Anderson & Munn, Woolworth Bldg., New York, N. Y.

VISION SHIELD FOR VEHICLES—Whereby a portion of the windshield is protected against the collection of rain, snow or sleet. Patent 1498671. J. S. Peden, 145 Vermilyea Ave., New York, N. Y.

TRACTOR GUIDE—Constructed to run in the furrow with a tendency to move to the land side. Patent 1499289. J. W. Buller, c/o Buller Coupler Co., Hillsworth, Kan.

CURTAIN CARRIER—For carrying the curtains of an automobile when they are not in use. Patent 1498661. A. P. Kyle, Pelican Motor Co., Glenmore, La.

SLED—With an arrangement of springs and auxiliary bumpers to yieldingly sustain the seat and absorb shocks. Patent 1499299. L. G. and F. R. Hatosy, 352 E. 143d St., New York, N. Y.

WAGON AND TRUCK DUMP—Having automatic means for locking the truck in position while it is being dumped. Patent 1498,-843. H. G. Knapp, c/o Magic Grain Dump Co., Minot, N. D.

BRAKE FOR VEHICLES—Adapted to be applied to an automobile and afford facilities for the driver to bring the car to a sudden stop. Patent 1498815. H. P. Sidelinger, c/o Eatwell Restaurant, Charlottesville, Va.

COMBINED DUST AND AIR CAPS FOR VALVE STEMS—For use in connection with pneumatic tires, and may be quickly locked thereon. Patent 1499247. G. W. Oakes, c/o Pittsburg Plate Glass Co., Crystal City, Mo.

AUTO LICENSE BUCKLE — Especially adapted to belt buckles, fitted with a cavity for removably holding the license or other small device. Patent 1488679. R. U. G. Jeannotte and R. A. de Montigny, address R. A. de Montigny, 95 Main St., Nashua, N. H.

IGNITION INDICATING AND DETECTING DEVICE—Which can be readily mounted on the instrument board of an automobile for indicating the condition of the ignition circuit. Patent 1500088. M. J. Neuner and A. A. Habermann, 133 23d St., North Bergen, N. J.

GLARE SHIELD FOR HEADLIGHTS—Serving to eliminate the blinding glare of a headlight to the eyes of pedestrians or drivers. Patent 1500075. C. H. Hipp and S. L. Kiser, 312 13th Ave., E. Hutchinson, Kan.

TRUCK—For use in handling express matter or freight from a car to the depot. Patent 1499530. J. W. Henderson, Tunica, Miss.

HOIST FOR MOTOR VEHICLES—For lifting or tilting a car in such manner that easy access may be had to the under body. Patent 1500284. W. L. Stubbs, 94 Maltby Ave., Ballentine, Norfolk, Va.

BRAKE-BAND LINING—Which may be detachably connected, making it easy to reline a brake. Patent 1500212. A. W. Statler, 1505 E. 23d Ave., Denver, Colo.

GLARE PREVENTER FOR HEADLIGHTS—Capable of ready application to the ordinary headlight in general use. Patent 1500941. R. H. Ireland, 9114 107th St., Richmond Hill, N. Y.

IDENTIFICATION DEVICE FOR VEHICLES—Which may be attached in such manner that the identification is clearly visible and cannot be removed without detection. Patent 1500980. R. Alfisi, 2243 83d St., Brooklyn, N. Y.

BRACE FOR FENDERS—To prevent rattling or vibration, as well as the sagging of the fender. Patent 1501834. D. S. Bachelder, 723 E. Cerro Gordo St., Decatur, Ill.

AUTOMOBILE ENGINE BRAKE—Which will control the braking action when using the engine in compression in coasting down hill. Patent 1501363. R. G. Noble, 374 Spreckels Bldg., San Diego, Cal.

SUPPLEMENTARY COOLING HOOD FOR MOTORS—Adapted to be placed beneath the ordinary hood, and causing the air to pass in the presence of all the cylinders of the motor. Patent 1501805. V. W. Page c/o Victor Page Motor Co., Melrose Ave., Stamford, Conn.

WHEEL—Combining the function of an ordinary wheel and an endless train of large anti-friction members disposed to carry a load with reduced friction. Patent 1502632. T. R. Hasley, Menominee, Mich.

AUTOMATIC TRANSMISSION FOR MOTOR VEHICLES—By which manual shifting of the speed gears is entirely obviated. Patent 1502953. H. R. Hoffman, 2069 Humboldt Blvd., Chicago, Ill.

HATRACK FOR AUTOMOBILES—That may be applied inside the top of any type of automobile without alteration to the car. Patent 1503298. J. A. Campbell, Carbondale, Ill.

AUTOMOBILE DIRECTION INDICATOR — Which is electrically operated affording pedestrians and other cars an indication of the turns to be made. Patent 1502940. H. T. Cox, 5676 York Blvd., Los Angeles, Cal.

SERVING TRAY FOR AUTOMOBILES — Removably engaging the edges of the body across the forward portions of the seats. When out of use may be stored in a small space. Patent 1501116. A. M. Inge, c/o W. J. Bacon, 1613 Central Bank Bldg., Memphis, Tenn.

BRAKE—For the front wheels of a motor vehicle, whereby to add to the braking facilities usually employed. Patent 1501311. W. Cooper, 11 Wheaton Place, Rutherford, N. J.

GEAR CONTROLLER—Adaptable to automobiles, tractors, motor vehicles, and numerous kinds of mechanical assemblies, for changing transmission mechanism. Patent 1501353. J. C. McDowell, Punta Rassa, Florida.

ANTISLIPPING DEVICE—Readily applied to or taken from a pneumatic tired wheel, and used with or without anti-skid chains. Patent 1502718. J. J. Ehmen, R. R. No. 2, Clayton, Ill.

LIFTING JACK FOR MOTOR VEHICLES—Which will serve to elevate a wheel when the vehicle is either advanced or moved rearward. Patent 1503532. A. L. Holton, c/o Interstate R. R. Co., Andover, Va.

TIRE-PRESSURE DEVICE — Wherein the parts may be set for a desired pressure, and will signal when this has been reached. Patent 1504119. O. H. Hansen, 540 40th St., Brooklyn, N. Y.

GRADE METER—For use with land, water or air vehicles, which will afford an accurate indication of the grade. Patent 1503672. F. W. Thompson, 210 Wholesale Terminal Bldg., Los Angeles, Cal.

AIR CHUCK—That will indicate to an operator when the desired pressure of air has been reached in filling a tire. Patent 1503663. J. W. Price, 825 So. Xanthius Ave., Tulsa, Okla.

Designs

DESIGN FOR A STOVE—Patent 65042. W. F. Allen, c/o Allen Mfg. Co., Nashville, Tenn.

DESIGN FOR A MORTUARY CANDLE—Patents 65070 and 65071. Evelyn L. Kuhn, c/o White Tar Co., 56 Vesey St., New York, N. Y.

DESIGN FOR A VEHICLE STEP—Patent 65008. V. W. Page, c/o Victor Page Motor Corp., Melrose Ave., Stamford, Conn.

DESIGN FOR AN INDIVIDUAL FRYING PAN—Patent 65213. S. C. Abbey, c/o E. Reilly, 502 E. 55th St., New York, N. Y.

DESIGN FOR AN INCENSE BURNER—Patent 65293. S. Morita, San Francisco, Cal.

DESIGN FOR A MONOGRAM MEDALLION RING—Patent 65362. C. T. and F. H. Wittstein, Warner and Arch Sts., Newark, N. J.

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Automotive

Guiding Without Seeing.—In addition to the proposals to equip French Channel ports with the Loth cable system, which enables vessels equipped with the necessary apparatus to guide themselves electrically by means of a submarine cable, it has been decided to equip the Paris-London airway with the system, so that in foggy and cloudy weather there will be no danger of airplanes straying from the direct route. A large number of French airplanes are to be equipped with the Loth apparatus. An overhead cable is to be provided between Paris and Boulogne and a submarine cable between Boulogne and the English coast. It is hoped that the first section of the line will be ready for use next May, for the difficulties which originally stood in the way of the scheme have been removed. Originally, the peasants across whose land the overhead line is to run protested and asked that the cable should follow the road. Such an arrangement would, however, have rendered the cable useless, as the route must of necessity follow a straight line. Finally, a decree of expropriation was passed, and nothing now stands in the way of the work being commenced.—*The Engineer.*

Nearly All Recent Research Work dealing with the effect of fuel and water on lubrication has made it evident that an engine which attains a good working temperature quickly is less apt to suffer from trouble due to dilution and water contamination of crankcase oil than one which heats up slowly and perhaps never attains a good working temperature during average short run service. This points to the desirability of having a minimum amount of water in the cylinder jackets and of preventing circulation until a good working temperature is attained. Granting this, a narrow jacket space has obvious advantages, providing proper circulation is assured. Another desirable arrangement, used to advantage in some aircraft engines and equally applicable to automobile engines, is one in which the water is brought in near the top of the jacket and close to the hottest parts, such as exhaust valves and spark plug, and is not positively circulated through that part of the jacket which surrounds the cylinder bore. This enables the cylinder walls to attain a desirable temperature quite quickly, the water surrounding them being circulated only by thermosyphon action, while parts likely to overheat are kept cool by the forced circulation around valves and head. An engine having this arrangement undoubtedly will attain a suitable operating temperature quite quickly, especially if jacket space is narrow, and consequently should be more nearly free from dilution troubles than engines in which the cylinder walls are kept too cool.—*Auto. Ind.*

A Flexible Locomotive Power Plant.—Everyone thinks he knows all about the steam locomotive, because it has been with us so long, but today we have a new steam locomotive. This statement is proved by the epoch-making records of the Altoona test plant of the Pennsylvania Railroad. The new complete power plant on wheels and rails produces power at the rate of one indicated horsepower for the consumption of 1.79 pounds of coal, with even higher efficiency to come. Records as low as 13.5 pounds of steam per indicated horsepower-hour put the steam locomotive in the class of efficient non-condensing power plants. Few persons know that locomotives have been built and are in service with power enough and flexibility enough to enable them to haul 10,000 tons at 18 miles an hour on level track on the one hand and to haul trains of 4500 tons with ten minutes' clearance ahead of a passenger train which is scheduled at 49 miles per hour for 90 miles without a stop, on the other hand.—*Research Narratives No. 82; Eng. Foundation.*

Only Thirteen Airplane Engines, Rated at 600 Horsepower or Over, have actually been designed and built. Seven were of French design, three were British, two American, and one Italian. Apparently only six of these engines have been developed to any great degree—three British, one French, one Italian, and one American.—*American Machinist,* 61:5, 4 pp., ill.

The Air Service to the new Rouyn goldfield of Quebec, which was inaugurated late last May continued to be a marked success all during the warm weather months. The new gold district lies in a general eastward direction from the famous silver mining camp of Cobalt, Ontario, it being regarded as an extension of the same geological area across the boundary into Quebec. The new region was at first accessible only by canoes following rather circuitous routes, and by foot. However, the difficulty of getting into the area for prospecting was altogether minimized by the opening of an airplane service whereby it was possible to fly into the new district in 50 minutes, at a cash fare of forty dollars. Passengers and supplies were transported almost daily during the whole summer and no accidents occurred. The service was maintained as a private enterprise, by the same company which ferried prospectors into the so-called "gold" district of the Labrador coast a year ago. The latter "discovery," it will be recalled, turned out to be a hoax committed by a timber prospecting party which wanted excitement. By ordinary means this locality was inaccessible until late in June, but the airplane carried in a large number of prospectors late in winter. No gold was found, but this, of course, does not detract from the feasibility of airplane service on such occasions. What would such a service, operating daily, have meant in the first days of the Klondyke?

Alcohol for Motor Fuel.—France is one of the nations that has taken alarm as to the source of volatile fuel, and elaborate experiments have been undertaken to determine how far a mixture of lcohol and common hydrocarbon fuel can be made practicable. A report on results so far attained appears in the *Ann. d. Chim. Anal. et Appl.* ([2], 1924, 6, 136), prepared by George Baume. It has been found that absolute alcohol is much better suited for admixture with the hydrocarbons than when water is present. With the absolute form, about equal parts of the two liquids can make a stable mixture. Some adjustment of the motor is needed to secure efficient service, but this problem has been solved. It is claimed that the alcoholized fuel is less likely to produce knocking. The manufacture of an alcohol containing only traces of water by the ordinary methods is an expensive process. The committee investigating the matter has adapted a method devised by Sydney Young and used in certain French distilleries. It consists in rectifying the alcohol in the presence of benzine. The distillate consists of benzine, water, and a small quantity of the alcohol; the greater portion of the latter remains in anhydrous form in the still. Operations of this character have been carried on to the amount of several thousand gallons per day. The problem of the denaturing of this alcohol has also been considered.—*Jour. Franklin Inst.*

Two-Hour Flights between Europe and America at an altitude of 10 miles and with 2000-horsepower motors, are forecast by S. Lindequist, a widely known Swedish airplane constructor. One of the greatest aims in aviation in the immediate future should be to cut down the flying time between continents, says Mr. Lindequist, and this probably can be done by flying at extremely high altitudes. The effect of gravitation decreases with the increase in altitude, and it has been estimated, he says, that a plane which has a speed of 100 miles an hour near the surface of the earth can attain a speed of 1200 miles an hour at an altitude of about 10 miles. At such a height the rarity of the atmosphere would constitute a disad-

vantage both to the ordinary motor and the ordinary propeller. But this difficulty can be overcome, declares Mr. Lindequist, by using a propeller with adjustable blades so that the pitch of the blades could be altered with the density of the air, and by using special compressors for the motor which would compensate for the decrease in barometric pressure at high altitudes. Such a motor would probably have to develop about 2000 horsepower.—*Auto. Ind.*

The Cuff-Valve Engine used at the Grand Prix races at Lyons, France, presents a very distinctive external appearance by reason of the two sides being exactly alike; there are a carbureter and an exhaust pipe on both the left and the right. Near the top of each cylinder barrel there are eight ports, the upper ring of four being for the intake, and the lower ring of four being for the exhaust. This explains why there are a carbureter and an exhaust on each side of the engine, for the ports are almost equal to the circumference of the cylinder, and there is an area both for the admission of the fresh mixture and for the evacuation of the spent gases of 2½ square inches for a cylinder having a total volume of practically 20 cubic inches. The Schmid cuff valve, which is the subject of recent patents in both France and foreign countries, has the advantage, in addition to providing a very big port area, of permitting exceedingly rapid covering and uncovering of the ports without, of course, any danger of the "floating" at excessive engine speeds. The cuff, which is a split ring nearly two inches in depth, weighs 4½ ounces, and is operated by an inverted steel T-piece, the stem of which is of circular section guided in the detachable cylinder head. The necessary reciprocating motion is given to the cuff valve by means of a train of spur pinions at the front and a couple of eccentric shafts contained in an aluminum housing bolted on the cylinder head. For each cuff valve there is a pair of short, circular section shafts, one telescoping within the other, each one mounted by a split bearing on to the opposed eccentric shafts. Connection is made from this pair of telescoping shafts to a bell-piece screwed on the extremity of the T-member, thus obtaining an irregular reciprocating motion of the cuff valve, the speed being high for the opening and closing of the ports, and practically nil during the compression and firing strokes.—*The Autocar* (see No. 1502).

A Soft Metal Hammer for Mechanics, which is made of metals that will not jam, dent or chip fine threads or machined parts has been put on the market by a Worcester, Mass., manufacturer. These hammers are made in weights ranging from 3 to 5½ pounds, the lighter weights being of babbitt metal and the heavier ones of bronze. Garage mechanics especially find such soft hammers valuable, for they have frequently to hammer fine parts which would be rendered shabby in appearance by pounding with the ordinary steel hammer.

Superchargers for high-speed racing engines run at tremendous speeds. Hitherto, says *Autocar*, no details of the actual blower speeds have been given, and it is interesting to learn that on one engine a double step-up drive gave the blower eight times the speed of the engine, so that at the maximum engine speed of 5200 r.p.m. the blower was driven at 41,600 r.p.m. It is further stated that an increase of 12 miles per hour was imparted to the speed of the car by the addition of the supercharger.

Discussing Alcohol as Fuel, Sir Charles H. Bedford stated at the World Power Conference that in many parts of the world active production or experimental investigation of the possibilities of producing power alcohol is being carried on, from raw materials offering the most favorable economic conditions in the particular area. Molasses, maize, sweet potatoes, flax pulp, cassava and nipah palm, are chiefly the bases employed. There are innumerable patented mixtures with varying amounts of alcohol in their compositions, but perhaps the three best known fuels are Alcogas, Discol and Natalite. These have been manufactured for some time in fair amounts and have been used successfully. Natalite is a complete substitute for petrol. In this it differs from most other alcohol fuels. It is self-contained, that is to say, it is essentially a mixture of alcohol and ether, the ether being easily and cheaply manufactured from alcohol. Small amounts of other substances are added to conform to the excise regulations which require all power alcohol to be denatured or rendered unfit to drink, and for other special purposes.—*Power.*

Civil Engineering

The Electrification of the Virginian Railway includes an 11,000-volt trolley line on steel structures over 134 miles of main line track and a total trackage of 231 miles, including double track, yard tracks and side-tracks; a 50,000-kilowatt steam generating plant at Narrows, Va.; an 88,000-volt transmission line carried on steel towers, largely across country on independent right-of-way; seven transformer stations to step-down the current to 11,000 volts for the trolley wire, and 12 electric locomotives of three units each, together with repair shops and inspection facilities. Each locomotive will weigh 625 tons. Two locomotives (one acting as pusher) will take a 6000-ton coal train up Clark's Gap Hill at 14 miles per hour, and one locomotive will take a 9000-ton train from Clark's Gap yard to Roanoke at 14 and 28 miles per hour, the lower speed being on the grades. The power plant, transformer stations, transmission line and distribution system will have a capacity for handling an annual coal tonnage of 12,500,000 tons, and the 12 electric locomotives will be sufficient to handle 8,000,000 tons annually.

A Novel Means of constructing "one-man" blocks of concrete blocks for jetties has been developed in Alabama. The idea was first suggested in 1915 by Major (now Colonel) Earl I. Brown, district engineer at the time. In the river are various bars of sand and gravel which are several feet above water level. In many places, this sand and gravel is, in its natural state, already mixed in proper proportions for making concrete. Small holes spaced about 2½ or 3 feet, center to center, are prepared in rows on the bar. A mixture of about 1½ gallons of water (the exact amount varying with the moisture in the bar) and a cup of portland cement (eight pounds) is then poured into each hole and mixed with sand and gravel, by shoveling, before the water has had time to soak into the ground. The result is a mushroom-shaped mass of concrete about 20 inches in diameter and 12 inches thick. These blocks are allowed to remain in place about three days, when they are sufficiently hard to be turned over with a pick. They are then allowed to harden in this position for about three more days, when they can be loaded on wheelbarrows and placed on a barge. In an emergency this time allowed for setting can be somewhat reduced. While the blocks are hardening in one part of the bar, new blocks are being prepared in another part. The blocks weigh from 150 to 155 pounds each and, from their size and weight, are convenient for handling by one man. The cost per ton, on the bar, will average about $2.25, with an additional cost of about 20 cents per ton to load on barges. It will be noted that there is no strain on them; they are made slowly for weighing down the brush or for the construction of all-rock jetties. Consequently, the quality of the concrete and variations in the proportions of sand and gravel are not as important as in other work. Besides being much cheaper than natural rock obtained from quarries down the river, these blocks possess the advantage of being uniform in size and are easily handled.—*Concrete*, 25:2, 2 pp., ill.

Twenty-five Thousand Miles of Wire, the strongest of its kind ever made, which tempered cuts ordinary steel as diamonds cut glass, will be used in the two cables supporting the world's longest suspension bridge, now being erected across the Delaware River to link Philadelphia and Camden, N. J. The wire, long enough to girdle the globe, is shown by tests to have a tensile strength of 223,000 pounds per square inch of gross section, and, after assembly into the cables, it will hold at anchorages against a pull of 36,000,000 pounds. The entire engineering scheme of the bridge is built around the strength of the cables. Engineers supervising the manufacture of the wire with the aid of new equipment and processes at the Monessen, Pa., mills of the Page Steel and Wire Company declare that the impregnation of unprecedented strength into the slender strands of wire that are only 192/1000 of an inch in diameter, opens new possibilities for erection of larger and longer suspension structures. The total length of the Delaware River bridge, including plazas, is 9760 feet, as compared with 5989 feet length of the Brooklyn Bridge.—*Iron Trade.*

Bizarre Concepts such as were contained in the early scientific fiction of H. G. Wells are not necessarily impractical. Utilization of the internal heat of the earth as a source of power is worth undertaking as an international scientific enterprise, said E. W. Rice, Jr., honorary chairman of the board of directors of the General Electric Co., at the World Power Conference in London. "The source of power which we must expect from solar radiation is the power obtained from volcanic regions through holes bored into the earth, as has already been successfully developed in Italy," Mr. Rice said. Another possibility exists in the interesting and important suggestion made by Sir Charles Parsons in 1904, and again in 1919, of boring a great hole 10 or 12 miles deep in some convenient and suitable place, to utilize the internal heat of the earth. This suggestion should not be allowed to lie fallow. I heartily agree with Sir Charles in his statement that the cost of such an experiment is trivial compared with the value of the possible information which might be gained by the investigation into this unexplored region of the earth. The cost would be much less than that of a single battleship. If only the people and their representatives had the faith and vision of science, the value of such an idea would have been put to practical use long ago. It is a big idea, worthy of a nation's enthusiastic support; in fact, it is worth undertaking as an international scientific enterprise—a suitable subject for cooperative work among friendly nations."—*Iron Age.*

An Interesting Piece of Work.—The 460-foot length of 44-inch riveted steel pipe which will constitute the outfall end of the temporary sewer now being built by the City of Los Angeles was recently launched, in one piece, towed to place and sunk in less than an hour. This length of pipe was riveted up on the beach, bulkheads were bolted on at each end to make the line watertight, and valves were put in for admitting water when the line was in position to be sunk. When the tide and wind conditions were right a steam tug towed the pipe out through comparatively quiet surf and with the aid of lines to a winch on a trestle over the site planned for the outfall, the pipe was maneuvered into place. Before sinking the pipe the shore end was pulled up the beach above tide level. This temporary outfall will carry the sewage that has been flowing down Ballona Creek. It is an emergency outlet to be used only about a year, by which time the city's new outfall sewer project is to be ready for service.

Electrical

The Application of Electricity has multiplied enormously in France. Factories are making appliances which formerly were bought abroad, and there are 120,000 workers directly employed in the manufacture of all manner of devices. The capital employed exceeds seven billion francs. The industry may be said to have caught up with its loss during the four years of war. The number of exhibitors of French nationality and origin in the electrical section of the recent Paris Exposition was 334, as against 120 in 1920, and the space occupied increased from 1000 square meters to 7000 square meters. Among the exhibits was a circuit breaker for a 220,000-volt transmission line.—*Elec. World.*

At the World Power Conference considerable interest was aroused in the sessions on electrochemistry and electrometallurgy by the announcement of Major Hj. Johansen of Norway that experiments completed last week indicate the success of a method to get 99.95 per cent pure iron by a direct process from iron ore in an electric furnace (see *Elec. World*, July 26, 1924). This was greeted, if commercially practicable, as the realization of a half-century dream.

In the Production of Metals from Ores electricity has come into play very greatly because it eliminates steps in the processes and in general produces a purer and better metal. Its still greater use, however, depends on reducing the cost of electric power and in further developing processes. On a commercial basis the electrolytic action of electricity is used most extensively for low-grade copper ores running between one and two per cent copper. In some cases, notably at Ajo, Ariz., in Chile, and in the Belgian Congo, very dissimilar ores are leached with acidulated water and the solution is then submitted to electrolysis. However, ammonia leaching with chemical precipitation of the ore is also used to produce copper in several localities. At Milford, Conn., the first American plant to use electricity to make iron from ore is in operation. This semi-experimental installation uses iron-sulfide ore and produces iron tubes by electrical deposition of the metal on a rotating iron mandrel. It has been found possible to make electrolytically pure metallic zinc

directly from zinc sulfate ore, and indications point to the possibility of producing nickel, tin and other metals directly from ores in the near future.—*Elec. World.*

The First Transcontinental Telephone Line was completed in the summer of 1914 and early in the following year three transcontinental telephone circuits were placed in commercial service. The opening of these first circuits, while marking a most important stage in the progress of long distance telephony, has been followed by many developments which have made possible increased overall transmission efficiency and improved quality. Two outstanding characteristics of these new open wire circuits are that they are non-loaded and that the repeaters are of an improved type, the number being increased in consequence of the higher attenuation. With these long non-loaded circuits increased speed of propagation and smoother characteristics are obtained resulting in less echo effect and better volume. Better attenuation-frequency characteristics are obtained and the quality is further improved due to the elimination, to a large extent, of transients. Changes in line attenuation with weather conditions are also considerably reduced. With the improved repeaters and balancing networks it is possible to obtain a higher degree of balance at the various repeater points. The improved transmission characteristics of these repeaters also contribute toward better quality. Both of these improvements are important in view of the increased number of repeaters in the circuit. The use of this improved type circuit has been extended during the last few years to connect a large number of the important cities in the United States. One of the most recently established of these circuits is the Chicago-Los Angeles circuit routed over the southern transcontinental line. This and other through circuits on this line from Denver via El Paso to Los Angeles were established last year in order to provide for the growth in transcontinental traffic and to make available a second route as protection for the through service to the Pacific Coast.—*Bell Sys. Tech. Jour.*, 3:3, 10 pp., ill.

Generating Power at the Mouth of the Mine is not nearly as feasible as it seems to many, says *Elec. World.* The proposal to establish near pit heads a number of superpower stations for electric supply has fired the imagination of laymen and newspaper writers both here and in England. Even engineers who ought to know better have succumbed to the suggestion. There is no doubt of the savings in generation of electricity made possible thereby; but the trouble is, and it is an insuperable one, that nature has rarely seen fit to put coal and water together. However, for every ton of coal burned under modern power-house boilers from 600 to 1000 tons of water is required to condense the steam discharged from the turbines. That is why superpower stations must in the main be built on large rivers or at tidewater, and that is why the great interior cities of this country and of England are handicapped in the erection of superpower steam stations. Coal is usually obtainable, water is not; and modern stations require a thousand times more water than coal. As a matter of fact, the Waterside station in New York City pumps more water for condensing purposes than the whole city of New York consumes for all purposes, and the same is true of the Commonwealth Edison Company of Chicago and numerous other public utility companies possessing huge steam generating stations. A station at the coal mine is ideal, but, like many ideals, rarely works out in practice.

A Submarine Cable in one continuous length of 2700 feet has been recently laid across the Hudson River at Garrison, just below West Point. The make-up of the cable and the method of laying it presented some features not encountered in every-day practice. The cable is to carry current from the east side of the river to the west side for local distribution in the immediate vicinity of Garrison. Power is to be transmitted at first at 2300 volts with ungrounded star-connected transformers, and this will later be changed to 4000 volts with the neutral grounded.—*Elec. World*, 84:8, 2 pp., ill.

General

The Secret of Hardening Copper, lost 2000 years ago with the passing of ancient Egyptian civilization, has been found accidentally by a railway switchman with an eighth grade education. The switchman, James Earl Cummings, 33, with a wife and six children between the ages of 1 and 10

years, today has a check for $1,500,000 paid him outright for his discovery by a big copper company in Detroit. He was broke a week ago. He was cleaning the copper gaskets of his automobile, a low-priced car of disreputable appearance, when he stuck them into a mixture which he "figured would clean them best." The gaskets, he discovered, would spring back to their bent form when he tried to straighten them. He told some of the boys at the shop about it, and they said his fortune was made. He patented the device, demonstrated it before officials of the large Detroit company and received a check for $1,500,000. This interesting but fictitious newspaper yarn is quoted in an editorial in *Chem. and Met. Eng.*, which continues: "It is surprising how many readers give credence to such a fable without stopping to weigh the probable monetary value of such a process, if there were such a process. To the ancients even the comparatively slight hardening obtained by cold work or the addition of alloying metals was of great importance, but in these days of alloy steels a method of making copper really hard would have only a limited commercial value on account of the high cost of the metal."

Power is being made a political issue, says *Eng. News-Record.* There is a form of political philosophy which holds that power can be generated by falling water and distributed to the home and factory for practically nothing—certainly for less than when steam is used as the generating force. This is a philosophy founded on ignorance or worse and its propagation is vicious in the extreme. The figures on the relative costs of power from different sources are sufficient indication of the complications of power cost to the consumer and an answer to those who assume that to insure cheap power it is only necessary for the state to develop its water powers. In and around New York City, for instance, local steam power and a combination of local steam and local hydro can successfully compete against plant-at-mine power and are not far in excess of the cost of local steam combined with St. Lawrence or Niagara power. Even at Philadelphia or Baltimore plant-at-mine power has little if any advantage over local steam or the combination of local steam and local hydro while at Pittsburgh, all three are about on a par. The reason for this apparent discrepancy lies chiefly in three things—the high cost of transmission, the limit on the location of mouth-of-mine plants imposed by the great volume of condensing water such plants need, and the fact that the cost of fuel in the region to which plant-at-mine power can be transmitted economically is so low that local steam plants can successfully compete against the larger plant.

Shall We Have a Christmas Tree Industry?—Instead of futilely berating a sentimentally callous world for denuding our forests of young trees to supply the great annual Christmas-tree market, the Northeastern Forest Experiment Station is trying out the possibility of growing trees purposely to supply that market. In a plantation of two-year-old Scotch pine that the station has just initiated for experimental purposes in cooperation with the Forestry Department of the Massachusetts Agricultural College at Mount Toby, Mass., Norway spruce seedlings have also been planted, on half the plots, at the centers of the squares formed by the 6 by 6-foot spacing of the young pines. Here it will be possible to test out the feasibility of raising Christmas-tree stock in mixture with a pine plantation, the spruce to be removed when it is large enough for a ready sale. By thinning out the spruce in this fashion, it is hoped that the growth of the other species will not be retarded. By planting half the plots in this way and comparing them at later observation periods with the plots on which pine only has been put in, the success of the experiment will be definitely determined.—*Jour. Franklin Inst.*

The Principle of the Davon Super-Microscope depends upon the use of a collector and secondary objective between the usual primary objective and the ordinary eyepiece of the microscope. The principle of the system consists, in essence, in replacing the usual eyepiece by a microscope (called the secondary). This is made practicable by the interposition of a specially designed lens (called the collector). The combination of collector and secondary microscope may be regarded as an attempt to constitute a superior principle in eyepiecing. Photography is thus performed with the three lenses: primary objective,

collector, secondary objective, with, in some cases, the addition of an eyepiece. In visual work the four lenses are used. When an object is in focus the pencils of rays which have passed through the objective diverge to form an image which is concentrated in and magnified by the ordinary type of eyepiece. In the super-microscope the function of the collector is to collect and concentrate these rays in the same way as the field lens of a Huyghenian eyepiece acts, but at a point much closer to the primary objective. The result is that an image is formed beyond the collector. This image is both smaller and brighter than that in an ordinary eyepiece and it is this image which the secondary microscope magnifies. The distance of the "Collector" from the "Primary" can be varied, and variable magnification obtained thereby in conjunction with the distance of the "Secondary" from "Collector."—*English Mech.*

It Takes Nerve, says *Eng. and Min. Jour.-Press* to pursue uncharted courses even when there is no alternative. Necessity may be the mother of invention, but courage is not always its offspring. During the war the Anglo Saxon Petroleum Co., in Sarawak, found itself confronted with a situation involving the possibility of serious loss were the wrong decision made. Some loss was inevitable, but the problem was to make it as small as possible. About 30,000 tons of distillate was on hand. Though of a value estimated at about £450,000, there was neither use for it nor storage capacity available at the moment. Its total loss by wastage was threatened. The novel expedient was adopted of pumping it into wells that were known to have almost exhausted the oil sands into which they had been drilled. Thus the entire 30,000 tons of distillate was disposed of, the pump pressure at times rising to more than 100 pounds per square inch. Later on, in 1919, these wells were pumped again, and it is estimated that about 14,000 tons of distillate was recovered in the form of a light crude.

Impracticable?—At a session of the British Association for the Advancement of Science held in Toronto, Ont., Prof. F. G. Donnan, of University College, London, said that when coal and oil are exhausted new forms of fuel will be obtained from common salt. Where water power exists near beds of salt (sodium chloride) the power will be turned into electricity and used to obtain chlorine from the salt, the chlorine gas to be transported to industrial centers for fuel. J. Alexander, a New York chemist, proposed the alternative solution that water-generated electricity should be used to break up water into hydrogen and oxygen, using both gases for heating, and perhaps also using the hydrogen in internal combustion engines. It was pointed out that millions of horsepower were going to waste because of difficulties of transmission which might be overcome by either of the two schemes suggested. Neither suggestion, in the opinion of *Coal Age*, seems as likely to be effective as the transmission of electricity in view of the expense of transporting gases even in pipes.

"The Technical Organization, its Development and Administration," is the title of a recent work by Weiss and Downs, published by McGraw-Hill Book Company. This is a practical discussion of the best methods of organizing research work for industrial purposes and of the conditions under which such work should be conducted. The book is intended for the manufacturer who is ready to organize a research laboratory, but who wants to know what such a laboratory will cost, what should be expected of it, what position in the organization it should occupy, how it should be directed, etc., etc.

Industrial Progress

Carbonization of Seaweed.—In various parts of Great Britain seaweed used to be collected for kelp burning, and afforded an appreciable amount of employment in districts where it was and still is badly wanted. The system of burning was crude and primitive, involving the loss of a large part of the available products; but dry seaweed contains anything from one-twelfth to one-sixth of its weight of chloride of potash, besides about six to eight pounds of iodine to the ton, and this would doubtless be worth having if it could be extracted at a suitable cost. The effect of substituting for the somewhat barbarous practice of burning the weed in order to recover its salts, or so much of them as are not lost in the operation, the more rational process of carbonizing it in a closed retort, collecting the products of distillation, and dissolving out the salts from the residual charcoal has been the subject of recent experiments. The results seem to show that the gas evolved in the process would, with the combustion of the residual charcoal, provide heat enough to effect the carbonization in addition to assisting the previous air-drying, and a fair yield of tar.—*Engineering.*

Can We Grow Rubber in the United States?—Mr. Henry Ford has apparently concluded to conduct practical and extensive experiments in planting rubber on American soil. For such demonstration he is credited with having bought in the vicinity of Labelle, Henry County, Florida, and contiguous to the Everglades, over 8000 acres, including a town site with buildings and public utilities. Here, it is stated, rubber culture experts will lose no time in getting the enterprise under way. An obviously adverse condition is that of latitude. The rubber tree is at its best in a warm, humid atmosphere. Southern Florida has a mean annual temperature of 70.8 degrees, with a slightly higher average in the proposed plantation area. This is rather lower than in proven territory, which is 77 to 80 degrees, yet it may be sufficient if other conditions be auspicious. Rainfall averages 52.09 inches there, in contrast with 90 in Chiapas and Tabasco, Mexico; 95 in Trinidad and the Guianas; and 100 inches or more in most rubber lands. An even temperature, and even distribution in rainfall seem to be quite necessary. Then, too, there is the cost of labor. For the Malayan plantations ample help may be had for as low as 50 cents a day. City help in Florida costs $4 and $5 a day. The great marsh lands he has secured have an alluvial soil rich in humus; they can be drained so that the tap roots of the trees may be in damp earth yet not in water; other physical drawbacks may also be largely offset. Moreover, the sub-tropical section selected grows trees found nowhere else in the United States, and some 187 varieties common to the West Indies and to Central and South America. Taken as a whole the outlook is very promising.—*Ind. Rub. World.*

A Series of Investigations covering the pulp processes and the suitability of American woods for pulp has been under way in the Forest Service for several years. Preliminary results in one of these investigations justify comment, says *Chem. and Met. Eng.*, 31:5, 3 pp. The wood in this experiment is chipped in the normal manner for chemical pulp; the chips are slightly but uniformly softened by chemical treatment and are then mechanically disintegrated. The high yields of 75 or 80 per cent of the original weight of the wood, the low cost of the chemical treatment and the low power requirements indicate the possibility, in some of the results very recently obtained with hardwoods and pines, that a very satisfactory pulp can be made at a total cost comparable with mechanical pulp. Spruce typifies the rigid requirements of the mechanical process, but the successful completion of this investigation would permit the substitution in mechanical pulp and hence in newsprint (usually 80 to 90 per cent mechanical pulp) of lower quality woods which are now considered valueless for this purpose. The newsprint mills which experience difficulty in securing spruce and fir pulp wood might be able to turn to the local domestic hardwoods at least during the stringent period of readjustment while growth of the softwood forests is being brought to a maximum. The greater the spruce shortage the greater will be the incentive to turn to this process or to develop one which would accomplish the same purpose. The Forest Service process promises also to make pulp from pine available as a substitute for sulfite.

Extremely High Steam Pressures are now evolving from the experimental to the practical stage, so that a plant using steam at 1200 pounds per square inch is no longer a pure curiosity. At the Weymouth power station of the Edison Electric Illuminating Co. of Boston there has been installed a high pressure power plant which consists of a boiler and turbine designed to operate at a maximum steam pressure of 1200 pounds per square inch. The boiler generates the steam and superheats it to 700 degrees Fahrenheit total temperature and then delivers it to the turbine. From the turbine the exhaust at 360 pounds pressure returns to the boiler where its temperature is again raised to 700 degrees Fahrenheit. The steam is then delivered to the main steam header for use in the normal pressure (350 pounds)

turbo-generators. The high pressure boiler and high pressure turbine are operated together as a unit, giving complete certainty as to steam path and division of load.—*Power Plant Eng.*, 28:15, 2 pp., ill.

Thermatomic Carbon.—The use of carbon, in the form of gas black, for reinforcing the tensile strength and resistance to abrasive wear of pneumatic tire treads and solid tires has become so general that in the United States alone 60,000,000 pounds are being used annually in rubber goods production. Briefly, this form of carbon is manufactured by the partial combustion of natural gas. A smoky flame of burning gas is allowed to impinge upon a relatively cold metallic surface which is slowly moved away from the flame and the black deposit scraped off. The soot thus obtained is sifted, bagged, and shipped to the rubber factories. This process gives a product excellent for many purposes, such as tire treads. The maximum yield which has been obtained suitable for use in rubber goods is about five per cent of the total amount of carbon in the original gas, or 1¼ pounds to 1000 cubic feet of gas. About two years ago a fundamentally different process was put into commercial production, differing from those hitherto used, in that the gas is not burned but rather is decomposed by heat. In technical terms the natural gas, which consists principally of methane, is "cracked" into carbon and hydrogen by passing the gas over preheated brick checker work in large vertical furnaces. The carbon thus obtained is filtered out of the residual gases, screened, and bagged in the usual manner. This is known as the Thermatomic process and is very economical, yielding approximately 30 per cent of the available carbon, in the gas, or 10 pounds instead of 1½ pounds by the partial combustion process.—*Ind. Rub. World*, 70:5, 1 p.

Remarkable Progress in the design of high-pressure boilers has been made by the production of special steels containing from three to five per cent of nickel at the Krupp Iron Works. Drums made of nickel steel and forged with the end plates in one piece without seams are most suitable for the very high steam pressures and correspondingly high temperatures. Such drums are naturally expensive. The number and diameter of boiler drums will evidently have to be reduced to lower the price of high-pressure boilers. The extent to which this is practicable will depend upon the sensitiveness of the combustion control. To secure the advantage of the low cost of high-pressure sectional boilers with their small drums and correspondingly small steam space, they may be supplemented by a steam accumulator placed between the high-pressure and low-pressure stages of the turbine. The accumulator acts as supplementary water capacity for the drum. Dr. Münziger, in addressing the World Power Conference at Wembley, stated that the electric-power station of the future would show the following characteristics: Steam pressure, 570 to 1400 pounds; boilers with a small water capacity; extensive use of feed-water heating by bled steam; steam accumulators in the low-pressure range; reheating of the steam; pulverized fuel and air heaters. Making full allowance for capital cost, the saving should be from 10 to 20 per cent for a steam pressure of 1400 pounds, as compared with 220 pounds.—*Power.*

Recently There Is an Encouraging Tendency to broaden the field of application of Diesel engines and to increase their size. Engines of 5000 kilowatts are proposed with the same degree of confidence by Diesel manufacturers as those of 500 kilowatts were proposed ten years ago, and many discussions have occurred as to the possibility of using Diesel plants of 40,000 kilowatts capacity and above. It is asserted that such plants operating with a thermal efficiency of about 30 per cent combined with the mammoth steam stations which also attain this efficiency form an ideal combination for efficient power production. Moreover, Diesel engines are proposed as sources of auxiliary power in very large steam stations, and they are suggested as auxiliary stations for hydro-electric systems.—*Elec. World.*

X-ray Analysis of Coal.—Considerable progress has been made recently, particularly in Great Britain, in the commercial application of X-ray analysis. This comparatively new development, concerning which considerable has been published in this country in the last year or two, is being applied both for the testing of metals and for the analysis of coal in Great Britain. The method is an adaptation of the X-ray stereoscope technique, the samples examined being first submitted to some preliminary treatment to "bring out" the constituents, such, for example, as treatment with pyridine to dissolve out soluble portions of the coal. In this way the mineral portions of the specimen are clearly shown.—*Iron Age.*

Japan Is Using More and More Gas.—In her ready acceptance of things Occidental Japan has discovered the value of manufactured gas for heating, both in the home and in factories, and there are now 76 gas companies furnishing this public service, with a total production of nearly ten billion cubic feet a year. This is double the amount of gas used in 1914, when there were only ten companies in the entire Island Kingdom. All the conditions making for the successful development of gas distribution exist in Japan, where the population, greater than that of Great Britain, is largely urban. Japan has 66 cities, varying in size from Tokyo, with more than two million inhabitants, and Osaka, with a million and a quarter, down to Otsu, with thirty-odd thousand, while, of these, 14 have more than four hundred thousand inhabitants each. Gas is used in the little Japanese homes for cooking and for heating in place of the charcoal brazier of earlier days. In addition to the wide use of electric lights, more than a million gas lamps are used in city streets, and with industrial heating applications in many factories there are in service more than 2300 gas engines, used to drive machinery in the myriad tiny factories that produce everything from ivory carvings to tooth brush handles, and from plaited-grass sandals to sausages.—*Am. Gas Jour.*

St. Louis to Be a Steel Center?—During the past few years more than usual attention has been given to the advantages of St. Louis as an iron and steel producing center. In view of this interest, *Iron Trade Review* (St. Louis number) some months ago undertook to make an impartial survey of the St. Louis district. The various factors affecting fuel, raw material, labor and market were analyzed carefully and a great mass of information bearing on the subject was collected. The survey shows that St. Louis unquestionably has important advantages in transportation facilities and in the cost of assembling raw materials. Its supplies of fuel, ore and secondary materials are abundant and accessible. It is quite evident that pig iron and steel can be made in this district at costs somewhat below the average of those prevailing in other producing centers. With cheap products possible, the remaining factor is the capacity of the market. The westward trend of manufacturing and the rapid development of the Southwest are daily adding to the volume of the potential iron and steel market of the St. Louis district. However, the demand for various products is not well balanced and this fact causes producers to proceed cautiously. For this reason, spectacular expansion of steel-making capacity in the district is not likely to occur immediately. Growth of production doubtless will be steady, and will be accomplished largely by natural extensions to existing works.

The Extraction of Petroleum from Coal by the low-temperature carbonization process is the object of a plant at Nottingham, England. The promoters hope to make Nottingham a smokeless city, to furnish cheap gas, and to reduce both waste and danger in the coal mines in addition to securing from 18,000 to 20,000 gallons of oil from every 1000 tons of coal—the expected daily capacity of the plant. Under present circumstances, England imports oil to the value of 50,000,000 pounds sterling a year. It is proposed to replace this supply as far as practicable with gasoline and other petroleum products to be separated from small coal heretofore regarded as almost a waste product of the mines.—*Comp. Air Mag.*

A New Use for the Sand Blast.—At the St. Louis pumping station, where steam turbines are used to drive centrifugal pumps, it was found that the efficiency of the units had fallen 25 per cent from the initial and guaranteed figures; and investigation revealed that the first five rows of turbine blades were almost completely closed with sediment. After the replacement of a few rows, the entire blading surface was given a thorough sand blasting. This effectually removed all the scale; and, upon the resumption of service, the original steam consumption guarantees were equaled. The sand blasting of boiler tubes is an established thing, removing soot as well as scale and

(*Continued on page 350*)

Lead
—*in your telephone**

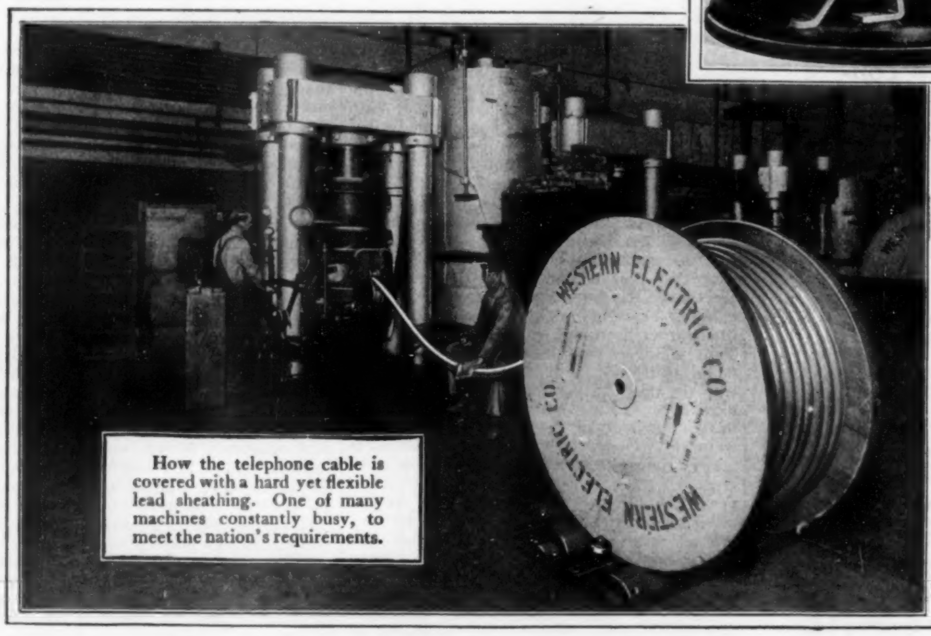
IN the manufacture of telephones, switchboards and telephone cable, Western Electric looks to the mines of Missouri for millions of pounds of lead each year.

These great shipments, in combination with other metals, are put to a variety of uses—ranging from the little dabs of solder on the terminals of cords inside your telephone to the heavy protective covering on the miles of telephone cable over which you talk.

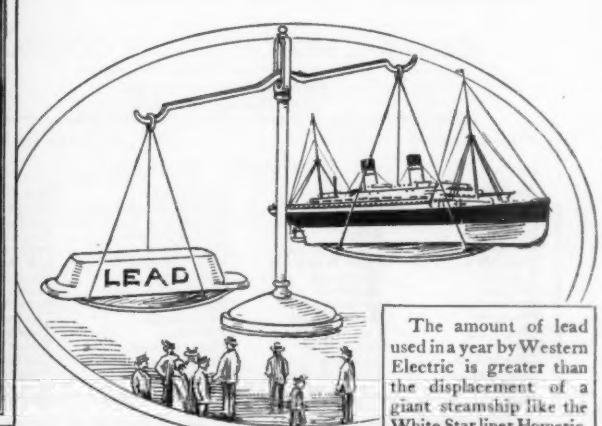
In these and other ways lead plays an important part in telephone service. How to handle this heavy material, how to apply quicker and better and more economical methods in moulding and pressing it, is a knowledge which Western Electric has acquired through fifty-five years' experience.

* *No. 9 of a series on raw materials.*

From the lead mine to a spool of solder. In this form lead assures permanent electrical connections between many of the small parts of your telephone.



How the telephone cable is covered with a hard yet flexible lead sheathing. One of many machines constantly busy, to meet the nation's requirements.



The amount of lead used in a year by Western Electric is greater than the displacement of a giant steamship like the White Star liner Homeric.

Western Electric

SINCE 1869 MAKERS AND DISTRIBUTORS OF ELECTRICAL EQUIPMENT

Scientific American Digest

(*Continued from page 348*)

leaving the metal surface clean; but the sand blasting of turbine blades seems to be an entirely new practice.—*Comp. Air Mag.*

Metallurgy

An Improved Mild Steel has recently been invented by F. G. Martin in Great Britain which possesses a far greater elastic limit than that ordinarily used in ship construction work. By the use of this material it is claimed that the plates of a vessel may be made considerably thinner and yet possess the same strength, and it will thus be possible to build a ship of given size lighter and therefore able to transport a heavier cargo with the same engine horsepower. The idea bids fair, according to some authorities, to revolutionize both the shipping and shipbuilding industries. That the invention is past the experimental stage is proved from the fact that a vessel in which this material is employed is at present in course of construction at Greenock (Scotland). By the use of this new steel a saving of 8.50 per cent in weight of material used will be made without any reduction in either the strength or efficiency of the vessel.—*Iron Age*, 114:8, ½ p.

Commercially Pure Aluminum Castings are now being made in large size and quantity, without any alloy whatever, and although these are quite successful for pans and vessels, the pure metal is not a satisfactory engineering material, with its low value physical properties, and the difficulty it offers to machining. For most purposes alloys are used, and several of these are of special importance. These are the alloys of zinc, copper, silicon and the new alloy of great promise, known as "Y" alloy, or L24, which contains two per cent nickel, four per cent copper and 1½ per cent magnesium. On account of its pouring temperature being 750 degrees Centigrade or about 90 degrees Centigrade above the usual aluminum alloy casting temperature, there is more risk of draws and surface cracks. It melts and pours very cleanly, and the resulting casting, with suitable precautions in surmounting the contraction difficulties, are distinguished by their fine finish and beautiful appearance, also for machining very well. In the ordinary cast state this alloy has no remarkable property in strength or ductility beyond its high thermal conductivity and retention of strength at high temperatures, which mark it as the best piston alloy yet developed.—*Metal Ind.*

The Production of an Alloy of Phenomenal Hardness, capable of cutting hardened steel and the toughest metals with ease, is the interesting possibility suggested by a leading British metallurgist. In the third Sorby lecture Dr. Walter Rosenhain of the National Physical Laboratory, in discussing "Present and Future Problems in Metallurgy," called attention to the advances made through the addition of small quantities of other elements to alter the properties of iron. At the same time he stressed the fact that but little is actually known about the causes of these changes. Dr. Rosenhain suggested that if some other elements were treated in the same way as iron immensely valuable results might be secured. For illustration he compared tungsten with iron. That metal is many times harder than the metal which forms the basis of steel. But iron is daily being rendered many times harder by adding suitable elements or by heat treatment or by both. The lecturer went on to say that if tungsten, which is many times harder than iron, could be treated in the same way, a product of superior hardness would probably result, although the immense difficulties in the way are at once recognized. Back of all this speculation as to the production of a "super tool steel" is the growing conviction that new combinations of metals will some day revolutionize the non-corrosive, magnetic and other steels. Plainly, our knowledge of alloy steels and alloys in general is only in its early stages.—*Iron Age.*

Mining

Some Oil-Shale Stock Promoters were Wrong, but oil shale isn't. During the boom days of 1919 and 1920 and perhaps as a part of the after-war fever of speculation that spread over the entire country, oil-shale reached its height of popular interest, says *Chem. and Met. Eng.* Under this generous patronage literally hundreds of promotional schemes flourished and bloomed only to wither and dry up once business depression and unfavorable conditions in the oil industry made their appearance. Just within the past few weeks, however, a number of developments have occurred that old timers regard as indicative of renewed interest in our oil-shale resources. Fortunately these signs point in the direction of sound technical and economic progress rather than to sensational and purely speculative development. Indirectly the Presidential Oil Commission—George Otis Smith, Rear Admiral Hilary P. Jones and Lieutenant Commander M. C. Robertson—are responsible for the present revival. As a part of its investigation of the Government's oil resources, the Commission directed attention to the naval oil-shale reserves—45,000 acres in Colorado and 86,000 acres in Utah of what appears to be the country's richest deposits. The chemist and chemical engineer will welcome this return of general interest in oil-shale technology. Even the lull that had such a terrific mortality among the promoters has not greatly discouraged fundamental research in the laboratories of a number of universities and larger oil companies. However, with confidence restored in the ultimate future of oil-shale, its many problems—economic and technologic—will be attacked with new vigor and better promise of success.

The Oil-Shale Deposits in the Uintah Basin, in Colorado and Utah, represent a potential oil reserve of great value. The extent of the interest being shown at the present time is indicated by the fact that some of the large oil companies have acquired property holdings of considerable magnitude. Shale is also known to exist in many of the eastern States, as well as in Nevada, California, and other western States. Continued effort is being made to develop these shales. Numerous companies have erected small plants, some of which have attained a degree of success. The encouraging feature, however, is that technical knowledge of the subject is increasing. With the gradual depletion of the underground reserves of liquid oil, it is merely a matter of time until the development of the oil-shales in the United States will be an economic necessity.—*Eng. and Min. Jour.-Press*, 118:8, 4 pp.

The New Element Hafnium, which was discovered recently by Coster and Hevesy, and which has some very interesting properties, is present in all zirconium minerals in appreciable amounts, ranging from 2 to 20 per cent. It is likewise present in so-called commercially pure zirconium oxide and salts of zirconium. It can be readily separated from the rare-earth elements, and resembles zirconium very closely in its chemical properties. It has a very high melting point and high power of light emission. The electron emission of the heated metal is very high, which suggests that possibly it would be of value in vacuum tubes for radio purposes. The element is abundant enough to make it available for commercial purposes.—*Eng. and Min. Jour.-Press.*

A New Process which produces electrolytic copper from the ore at the mine is described in *Can. Min. Jour.* (45:32, 4 pp., ill.) After crushing (and roasting, if the ore is sulfide), the ore is made into a pulp with water and sufficient sulfuric acid to effect solution of the copper. After a few hours, electrolysis is commenced and thenceforth proceeds contemporaneously with solution until the economic limit of extraction has been effected. The apparatus required is simple and inexpensive, almost half the acid consumed is regenerated, and the electrolytic copper is produced with about half the amount of electric current usually required. By this means the expense of concentrating and transporting the ore is obviated; and in place of the smelting method now in vogue in Canada, a more economical method is provided. The new process also offers a much more economical method of treatment than the leaching methods now in use.

Scottish Coal was first introduced into the Montreal market in large quantities only a little over a year ago and now it is recognized as a steady and fast growing competitor of American anthracite. In the second year of its use the imports will be double those of the first year. The benefits of the introduction of Scottish coal in Canada are more than those to the mere consumer—for it affords return cargoes to Canadian and British boats carrying grain eastward. As a result of competition the price of anthracite has been lowered $2 per ton to the consumer.—*Can. Min. Jour.*

Civil Engineering Notes

Electrification in Mexico.—The survey of the section of the Mexican National lines between Monterey and Cernetos, which it is proposed to electrify, has been completed; and all that is needed to put the scheme into effect is the signature of the President. At the same time with this improvement, the National Railways are considering the installation of the radio upon all their trains.

Oil from Ship's Ballast has been so frequently discharged into British harbors that it has been made a penal offense to discharge it within the three-mile limit. But the annoyance of running out of harbors and putting to sea in order to expel ballast water taken into the fuel tanks to displace the used oil has been done away with in an English port by the use of an especially equipped 250-ton barge for the purpose of receiving this mixture, separating out the oil and draining away the water. The oil is first run into a cone filtering compartment, where it passes through a number of superimposed cones and drains into the scum storage tank. The residuum, which is now an oily water, passes through cascade filter compartments and the remaining water is run overboard. The barge can handle about 200 tons of ballast water per hour. In a recent test, 60 tons of oil were recovered from a 2000-ton ballast tank.

Light Feeder Railways are being added to the Argentine railroad system in four districts where the expense of broad gage lines would not be warranted. Owing to the level nature of the country it is possible to lay 24-inch gage lines using 20-pound rails bolted to steel ties, making units of 15-foot length. These lines were designed mainly for potato-growing and cereal-producing sections where the cost of carting over dirt roads with long hauls has been excessive.

Another South American Transcontinental Railroad to be completed before 1925, will extend the present northern Argentine system to Atocha, in Bolivia, where it will join an already existing line which connects with northern Chile and Peru. According to *Railway Review* this will give Bolivia access to the east coast, bringing La Paz within 3½ days of Buenos Aires, and will shorten the regular New York to Buenos Aires route by 450 miles, the new route being via the Panama Canal, down the west coast of South America and across on the new line.

The First All-Steel Sleeping Cars for Europe have now been put in use in the principal European countries. *Railway Age* states that these cars are to be equipped with all conveniences to be found on the American Pullman car, and that a dressing room will be provided for each pair of compartments. The cars are 77 feet long and weigh 60 tons. They are heated with hot water and lighted from underslung dynamos.

Cast-iron Pipe in meter lengths installed in France 250 years ago has been found to be in good condition and is still in use. The pipe-line was installed to provide water for an elaborate system of fountains for the king of France, but has been used for other purposes since the king business went out of style in the French Republic.

A Mammoth Car Ferry for use between Anchorage and Baton Rouge, La., was recently launched at Neville Island, Ohio. This boat will be 340 feet in length, will have an extreme deck width of 91½ feet on a molded beam of 56 feet; and will carry at one trip a complete train of mogul engine and 11 Pullman cars or 25 loaded freight cars. The cost will be a quarter million of dollars, and the ferry will be the largest vessel of its type.

Oil Shale in Indiana.—The Bureau of Mines calls attention to a shale deposit not far from New Albany, where there is an outcrop estimated to carry 45 billion tons, with more than can be estimated available by underground mining after this shall be exhausted. The Bureau calculates that at least 10 gallons of oil per ton could be distilled from this shale, if there were but a commercial method of doing it. More and more it becomes clear not only that the hope of the future is in these shales, but that it is a very real hope indeed.

Reversible Rails Approved in India.—Double-head rails of the old reversible type, originally used on British main-line railways, are preferable to the more modern type of bull-head non-reversible type now generally used, according to a paper by R. Strachey,

chief engineer of the East Indian Railway. Double-head rails as laid originally had the lower head resting on the cast-iron chairs and thus became indented so as to form a rough surface when inverted or reversed. With the cast-iron plate and pot ties used extensively in India, the rail is supported by its upper head resting on bearings, the lower head being free of any support.

Aeronautical Notes

Tests of the "Alula" Wing.—A recent issue of the London *Times* gives an account of a recent demonstration at the Northolt airdrome of the capabilities of the "Alula" airplane wing, the invention of Alex. Holle, a Dutchman, who, with a Dutch organization, has been working in England for a number of years at the task of producing a wing for airplanes that shall give a greater lift in comparison with the area than that of wings of accepted design. For the purpose of the demonstration, the wing was fitted to a Martinsyde "Semi-quaver" machine with Hispano-Suiza engine of 300 horsepower. To provide some sort of comparison with the performance of a machine with normal type wings, a Bristol Fighter was flown side by side with it. The Martinsyde with the new wing got off the ground very quickly, went up at a sharp angle, and reached a height of 3000 feet in 72 seconds. It attained a maximum speed of 180 miles an hour. The "Alula" wing is shaped much like the spread wings of a seagull. It has no struts and is made of mahogany planking. It is pointed at the extremities, curved slightly back, and thickened towards the fuselage. It is slightly streamlined. Although the designer set out only to get increased lift from the wing, he has gotten also increased speed. The wing can be designed for weight-carrying purposes or for speed.

Making Wind Tunnel Tests Accurate.—In a recent issue of *U. S. Air Service*, Dr. Joseph S. Ames, Director of the Physical Laboratory, Johns Hopkins University, and also chairman of the executive committee, National Advisory Committee for Aeronautics, brings out some interesting points regarding the present practice to construct a model, one-twentieth the size, or less, of a contemplated machine, and to experiment with it. The method now in use is to suspend this model from suitable balances in a stream of air drawn through a large tube at a velocity of 60 miles an hour or more. The balances register the forces and moments acting on the model. From the results of such measures one decides whether the original design is good or not. But is one justified in making such a decision? Why should the same laws apply to a little model inside a wind tunnel, as it is called, and to the actual airplane flying freely through the air? Evidently there is ground for grave uncertainty. The committee has perfected a method of obviating this. It has been known from aero-dynamic theory for some time, that the change in scale, from the airplane to its model, could be compensated by compressing the air from the ordinary pressure to 20 or 25 atmospheres; as the structure moving through the air is reduced in size from 50 to 2 feet, the molecules of the air are brought, by compression, closer and closer together until their distance apart is one twenty-fifth of what it was originally. The effect of a change in scale is thus fully compensated, and experiments upon a model in this compressed air have a real meaning.

Mechanical Engineering Notes

Tests of Welded Rail Joints which were made by the Bureau of Standards resulted in a failure of the welded fish plate at 200,000 pounds, while the thermit weld failed at 600,000 pounds.

Straight Carbon and High-Speed Steels may be distinguished by the spark test on a grinding wheel. The presence of tungsten in the high-speed steel causes a dark spark, while the straight carbon or tungstenless steel will give a voluminus bright spark.

Working, Not Walking, is the clever catch-word that carries the advertising of a miller that is so designed as to make it unnecessary for the operator to step out of a rather small circle in front of the machine. All the controls are carefully located so that from this position he is able to make all feed and speed changes.

Ball and Roller Bearings.—The maker of roller bearings puts the emphasis upon the easy, instant and almost automatic adjustability to take up wear. The maker of ball bearings counters with the boast that after long periods of service the original surface of balls and race is discernible under the microscope, and that adjustment against wear is not necessary during the life of the mechanism served by the bearings. Who is right?

"Duraloy" is the name of a new alloy of iron and chromium for resisting oxidation and corrosion. It is made in all shapes, and if the alloy is used for castings these are clean and close grained. The tensile strength of the cast alloy is 40,000 to 90,000 pounds, the forgings running from 80,000 to 130,000 pounds, per square inch. The new alloy is able to withstand high temperatures without oxidation or warping.

Up-to-Date Equipment.—An extreme instance of the necessity for replacing old machines with new at the proper time is noted by *American Machinist*. The successful bidder for a certain small job made a good profit at his figure of $225. The unsuccessful bidder's figure was $350, and he would not believe that his competitor was not cutting his throat until it was proved to him in black and white that the difference in cost lay in a difference in time required. The up-to-date shop could do the work in 48 hours, whereas the losing bid was made on a basis of 155 hours.

The Inaccuracy of Early Machine Tools was attested to in an address by D. S. Kimball, of the College of Engineering, Cornell University. When Watt began to build his steam engine he complained that one of his steam cylinders had a long diameter which exceeded the shortest by three-eighths of an inch. But his troubles were apparently ended by Wilkinson's boring machine so that it became possible to bore a 50-inch cylinder which "did not err the thickness of an old shilling in any part." What would have been the reaction of a shop foreman of these "good old days" had the refinement of work to the modern degree where ten-thousandths of an inch are the criteria been mentioned.

Reclaiming Leather Belts.—Estimates resulting from an investigation of scrapped leather belts in industrial plants show that about 65 per cent of the belting that is discarded has in it a period of useful life sufficient to justify reclamation. This is the opening statement of an article by F. E. Godding in *Industrial Engineer*; and in the balance of the article he makes good on this claim, and shows just how others may make good on it.

Where Old Traffic Problems Are New.—One who reads carefully the British motoring journals must be forcefully struck with the fact that Britain, characteristically unwilling to learn from the experiences of others, is going through all the growing pains from which American motordom suffered ten and fifteen years ago. Violent controversies are waging in the correspondence and editorial columns of our British contemporaries as to whether one should turn off one's lights on meeting another car on a (presumably always narrow and rough) road and a (usually) pitch dark night; as to whether the car at the left (bearing in mind the British rule of the road) or the car on the main road should have right of way; and on numerous other points which we have long ago settled to our own satisfaction. The use of dimmers seems to be just at the point where the more radical British drivers are willing to experiment in this direction. Comment is elicited by the fact that a magistrate fined the driver of a farm tractor for going on the main highway without license plates.

Travel and Exploration Notes

Cultivated Land in England.—Cultivated land in England and Wales is now about the same as the pre-war area, but permanent pastures are less extensive, according to reports to the United States Department of Agriculture. The cultivated land has been decreasing since 1918, when it amounted to 12,399,000 acres. It now amounts to 11,311,000 acres, compared with 11,335,000 acres in 1912. Permanent pastures now occupy 14,715,000 acres, compared with 14,589,000 acres in 1918 and with 15,839,000 acres in 1912.

Quasimodo Loses His Job.—All those who are fond of reading Victor Hugo will be shocked on learning that the ancient bell-ringers of Notre Dame in Paris will give way to modern mechanical efficiency. The dwarf will no longer swing madly through the air at the end of a rope, for an electric motor will now do the work. For this change, the high cost of bell-ringing is the cause. This

curious business is hereditary in France and the work of Quasimodo has been carried on for generations from father to son and even to daughter, for the last of the line is a woman. She is now compiling a written manual for guidance of future bellringers.

A Baluchitherium in New York.—The American Museum of Natural History will soon have a new wing in which to house its rare collection of fossils and other specimens from the Orient. Work on the wing, the first to face Central Park West, has been begun and in a year and a half it is expected that the new portion, for which the city appropriated $1,500,000, will be completed. One of the most important collections to be housed in the Asiatic Hall, as the new wing is to be called, will include the giant mammal fossil recently discovered in China, in the Desert of Gobi, by Dr. Charles Berkey, professor of geology in Columbia University. Prof. Berkey was leader of the third Asiatic expedition of the museum and was in China for five months. Roy Chapman Andrews, who accompanied Prof. Berkey, will remain with the expedition four years longer. Walter Granger is fossil hunter in chief. The mammal is described as similar to one discovered a few years ago in Baluchistan, and consequently is known in the scientific world as Baluchitherium. Prof. Berkey's prize giant has a head about five feet long and measures over all thirty feet. Not all the bones are intact, and a few are missing, but the explorers believe that they will be able to reconstruct the body and exhibit it to the world practically as it lived centuries ago. This type of mammal is not found in either Europe or North America.

Popularity of Our National Parks.—Our national parks are becoming more and more popular. Over a million and a quarter persons visited them in one year, according to the report of the Director of the National Park Service. What with high steamer rates and the passport nuisance, it is little wonder that many tourists seek our own land, rather than turn to Europe. The great beauty of these parks and the fact that they furnish an all-around playground the entire year accounts for the increasing number of visitors. Over 60,000 visitors camped out with their own equipment in Yellowstone Park during the past year.

Concrete Stove Pipes Conserve Park's Beauty.—Not wishing to mar the natural scenery of Woodland Park, in Seattle, by ordinary chimneys for the camp stoves, the park board has solved this esthetic problem by the erection of concrete imitations of trees. Sections of bark were used to make plaster molds, into which the concrete was later poured. The result was tree-like chimneys twenty feet high, tall enough to disappear among the trees. The color of the concrete was varied so as to match the dark brown of fir and cedar.

Why Geysers Erupt.—Geysers have often been compared to volcanoes, presenting in miniature, with water instead of molten rock, all the phenomena of a volcanic eruption. The source of the heat is the still hot lavas below the earth's surface and is connected with the past volcanic energies of the park region. The accepted theory of these natural steam engines, which bears the name of the illustrious Bunsen, depends upon the well-known fact that the boiling point of water rises with the pressure, and is, therefore, higher at the bottom of a tube than at the surface. In the long and narrow or irregular geyser tubes the ebullition in the lower part of these tubes is only possible at a much higher temperature than causes water to boil at the surface due to the weight of the water column above it. The heat from the hot lavas continuously applied to water at the bottom of the geyser tube causes it to be heated to a high temperature, while the water near the surface is still cool. Eventually the water at the bottom reaches the pressure boiling point, when steam is formed, lifting the water above it and causing an overflow at the top. This overflow relieves the pressure, and all that part of the column whose temperature was previously below the boiling point but now exceeds it, flies into steam and ejects the water above with great violence. The water thus erupted flows back into the tube or percolates through the porous lava and is reheated for the ensuing eruption, whose period depends upon the intensity of heat. Some small geysers erupt every few minutes, while the interval between eruptions of some of the larger geysers is measured in days and even weeks. Old Faithful, the tourists' friend, erupts usually every 65 minutes. The water is thrown out to a height between 120 and 170 feet for 4 minutes; the estimated discharge is 200,000 gallons at each eruption.

Poor Columbus.—Now they are trying to make a Spaniard out of Columbus. A Spanish student named Sanchez claims that the real name of Columbus was Colon, and that he was born in the Spanish village of Pontevedra. Among the many documents and photographs shown in his book is what purports to be the reproduction of an agreement signed by the explorer and King Ferdinand in which the name Colon is used. The author also claims that Columbus did not know the Italian language and that all the documents left by him were in Spanish. He advances the argument that Columbus first named the land he discovered San Salvatore, which is the name of the parish in Pontevedra which is supposed to be his birthplace. Naturally such claims have raised the ire of the Italians who insist that Columbus settled the matter in his own life time when he stated that he was born at Genoa. Unfortunately the great Spanish author Ibanez intends to write a novel with Columbus as a central figure and it is not likely that such claims of Spanish births will be lightly thrown aside by the author of "The Four Horsemen."

A Tale of a Lighthouse.—Bishop's Light rises near the Scilly Islands and gives a grim warning of the dangers of the coast. It is one of the most exposed lighthouses in the world and the three tenders have a lonesome time. During a recent spring storm the beams from Bishop's Rock came near to failing. The light weighs several tons, and revolves on supports resting in a circular trough of mercury, it is balanced so delicately a child may turn it by a touch of the finger. On this night the tower was so shaken by the heavy seas that much of the mercury was spilled out over the concrete floor of the light chamber. The three guards fell on their knees, scooped up the mercury in their hands and poured it back into the trough.

An Undersea Expedition.—Dr. Roy Waldo Miner, Curator of the Department of Lower Invertebrates of the American Museum of Natural History, has recently returned from a trip to the Bahama Islands in the interests of a new exhibit planned for the Hall of Ocean Life of that institution, now in the course of construction. This exhibit is to show a twenty-five foot section of a coral reef as it appears under its natural living conditions in the wonderful coral lagoons of Andros Island in the Bahamas. Along the shore of this beautiful palm-dotted tropical island extends a line of coral reefs for a distance of sixty miles, enclosing a lagoon a mile in width, within which are thousands of coral clumps, or shoals, each one a marvelous sea garden in itself. It is planned to select one of these clumps as a basis for a new group, and to depict the wonderful variety of corals, sea fans, sea plumes and reef fishes of brilliant colors characteristic of such localities. In connection with this work, it is planned to cooperate with Mr. J. E. Williamson, the inventor of the famous undersea tube which is now located at Nassau in the Providence Islands. During his trip, Dr. Miner descended in this tube, through the courtesy of Mr. Williamson, and looked out upon the submarine world through a plate glass window one and one-half inches thick. The use of this tube will facilitate an accurate and authoritative study of undersea life to a degree not otherwise possible. Diving apparatus will still be used for collecting the specimens yet necessary for the group. It is expected that three years will be required to complete the group and when finished it will be the largest and finest portrayal of submarine life in existence.

Grasshoppers in a Glacier.—In south central Montana is located the "Grasshopper Glacier" where one may see myriads of grasshoppers imprisoned in an icy tomb.

Bardoo a Lost Island of the Pacific.—In the far south Pacific is a forgotten isle called "Bardoo," which is ruled over by a widow of an Australian who went there originally in the hope that missionary work would assuage her grief over the loss of her husband. She is now the supreme ruler of the island which contains only three other whites.

Interesting Old Tunnels.—The following is from a paper by Lester S. Grant, dean of the Colorado School of Mines, read before the Teknik Club of Denver: "In 1530 Agricola, a German mineralogist, re-

corded that the gold and silver mines of Schemnitz, Hungary, had then been worked for 800 years; the lead mines of Goslar, Germany, for 600 years; and the silver mines of Freiberg Saxony, for 400 years. Subsequent working of these mines necessitated the driving of drainage tunnels of lengths as yet unequaled in the history of mining. The Tiefe Georg tunnel, in Saxony, driven between 1777 and 1799, is 34,529 feet long, with branches amounting to 25,319 feet more. This was driven entirely by hand to obtain a drainage depth of only 460 feet. The Joseph II tunnel at Schemnitz was started in 1782 but not completed until 1878. It is ten and one-quarter miles long. The Rothschonberger tunnel at Freiberg, driven between 1844 and 1877, totals over 95,149 feet, the main tunnel being 42,662 feet. These tunnels were all driven by hand, using black powder."

New York's Fossil Forest.—The recent discovery of a fossilized forest at Gilboa, Schoharie County, N. Y., was made by excavators engaged in work for the New York City Water System. Dr. John M. Clarke is planning to reproduce in the state museum a section of the forest making it look as nearly as possible as it did in the Pleistocene age. Only the fossilized stumps, two or three feet high, of the Gilboa trees were found standing. The remainder of the trees were probably cut off by a glacial upheaval. The fossilized remains of the trunks and foliage lay alongside the stumps. The foliage was partly like a fern and partly like a palm. The trees grew 35 feet to 50 feet high, the inside being hollow and containing a pithy substance. The bottom spread out like a bulb, and the roots extended from underneath like those of an onion.

Archæological Notes

"Buried Cities."—Archæology seems to appeal to children, but rarely are articles on this subject written for them, so that a book on this science for young readers is a novelty. The Macmillan Company has just issued a book by Jennie Hall entitled "Buried Cities." It is written for children ten to twelve years old, is profusely illustrated and deals with Pompeii, Olympia and Mycenæ. It is an excellent piece of work and should stimulate readers to acquire a more extensive knowledge of archæology. We have little popular literature on Mycenæ and Olympia for which reason the book will appeal to older readers as well.

The Queen of Sheba's Son Flew an Airplane?—There is some reason to believe that some one fabricated an airship which Solomon gave to the son of the Queen of Sheba. Of course there was no motor—possibly it was a glider. The Secretary of the Royal Aeronautical Society in the preface to "Bibliotheca Aeronautica," states that Solomon gave to the Queen of Sheba "a vessel wherein one could traverse the air for wind, which Solomon had made by the wisdom that God had given unto him." There are other references to flight in Abyssinian sacred writing, and there is a long description of the miraculous way in which the Queen of Sheba's son Menyelek left Solomon, journeying to his mother's country. "No man hauled his wagon, and whether it was men, or horses, or mules, or loaded camels, each was raised above the ground to a height of a cubit." A cubit, according to the ancient Egyptians, measured about 20 inches, but elsewhere it is recorded that over the Red Sea they were lifted up three cubits, "and every one traveled in the wagons like an eagle when his body glideth above the wind."

Improvements in Palestine.—Jerusalem is being improved to an unheard of degree and is being made more and more comfortable for tourists. The Palestine railways have been very much improved, and the company has equipped the trains with new dining and sleeping cars. David's Tower has been cleaned out and the gardens designed by Herod have been restored to their original state as far as possible and may be seen by the tourists who visit Jerusalem. The famous tower, which was used by the Turks as a citadel from the thirteenth century until the time the city was captured by Lord Allenby at the head of the British forces, was built by King Herod and named after David.

The Diversion of Nile Waters for Exploring.—The waters of the Nile cover the underground chambers of the pyramids of Rameses II and Amenemhat I at Lisht. G. Maspero, the great Egyptologist, was baffled when he tried to work on these pyra-

mids because of sewage from the river. He tried to pump it out, but found the water flowed from one underground recess to another, so that pumping operations on a gigantic scale would be necessary. Modern pumping machinery has made it possible for the Metropolitan Museum of Art archæologists to proceed with their work. These pyramids belong to the kings of the twelfth dynasty and are more than 4000 years old. They have been thoroughly rifled above the water level by ancient and modern thieves. It is probable that the lower parts were robbed before the waters of the Nile entered the place. But the early robbers usually sought only gold and precious stones, leaving heavy objects behind. These submerged chambers, therefore, are virtually virgin soil for the archæologist and may have a rich yield. Pumping operations probably will begin next autumn. Mr. Lythgoe will have charge of the exploration.

Neglected Carthage.—During Arab occupation little injury was done to ancient remains; but modern contractors are now carrying off stones for the construction of villas. Five independent archæological parties have been at work on the site. Their uncoordinated studies show that many a treasure lurks beneath the soil; but unless there is central direction of some kind, the excavations may destroy almost as much as they add to knowledge. Excavations on the site of ancient Carthage are being conducted by a party of Americans working in cooperation with French archæologists. Their work is timely, as the site of this city is in danger of becoming a modern suburb of Tunis.

The Babylonian Account of Paradise and the Fall.—One of the most surprising discoveries of the German expedition at Ashshur was a tablet containing an account not only of creation, but also of the long-sought Babylonian Garden of Eden, the fall of man, his destruction and re-creation, and the redemption of the gods by the death and resurrection of Marduk. G. A. Barton shows its relation to other Babylonian myths, to the Egyptian myth of the death and resurrection of Osiris, to the Book of Enoch, and to the Gospel accounts of the death and resurrection of Jesus. In regard to the last point, he concludes that, making the most liberal assumptions, and granting that in some unknown way the Babylonian myth may be the origin of certain minor features of the Gospel story of the resurrection, the addition is so small and relates to such unimportant details that it strikes nowhere near the nerve of the historic facts which underlie the narratives of the resurrection of Jesus.

A Basque Museum.—M. Radet announces that the creation of a Musée Basque at Bayonne has been definitely decided upon. The *Société des Sciences, Lettres, Arts et d'Etudes régionales*, which is in charge of the establishment of the new museum, expects to gather a collection of utensils, furniture, pottery, textiles, inscriptions, coins, armor, grave monuments, portraits and other objects illustrating the arts of the Basque region in the past, and also examples of the products of its modern industries, great and small.

An Echo of Romantic Verona.—The tombs of the Scaligers at Verona have long been celebrated in the annals of the city of "Romeo and Juliet." The sarcophagus of Can Grande was opened a short time ago. To everyone's surprise, the body of the prince was found almost complete intact, mummified. The sage and wormwood placed with the body had served to embalm it. It was clothed in draperies of rich silks and gold and silver brocade; these too were in good condition. No jewelry or armor was with the body except the fine, large sword. The results of the investigation of the tomb prove the untruth of the tradition that the sarcophagus was looted in the time of Napoleon—and, incidentally, that a stirrup in the Metropolitan Museum is from a part of the armor taken out at that time. For no one taking other things from the tomb would have left the most valuable treasure of all, the sword. Besides, the body showed no appearance of having been disturbed.

Rents in Ancient Rome.—The housing question seems to have been acute at times in ancient Rome, and disputes between landlords and tenants were not infrequent. Researches show that in about 150 B. C. a Senator of Rome appealed to the courts against his landlord, who had demanded of him 6000 sesterces a year—say $300—for a house which had been rented at only half that sum. Crassus, long famous for his wealth, made much of his fortune through the building of houses which he rented by the year. He had trouble with the courts when he tried to make a tenant pay 15,000 sesterces for an elegant bachelor's apartment. Against these abuses Cæsar promulgated a law according to which landlords could never exact more than 2000 sesterces or $100 a year for villas in Rome or more than 500 sesterces or $25 in the rest of the country. Gouging landlords never had a chance in ancient Rome.

A Roman Theater at Ferentino.—The remains of a Roman theater, 65 feet in diameter, dating from the second century of the Christian era, have been discovered in a garden at Ferentino, about 50 miles south of Rome. A fine background is provided by the range of the Monti Lepini and the Valley of the Sacco, along which the railway runs from Rome to Naples. The ancient Ferentinum was a city of the Hernisi, taken by the Romans (as Livy tells us) and destroyed in the second Punic war. It afterward became a Roman colony and was selected by Horace as a typical quiet country town where the nerve-fagged Roman could recuperate.

Only One of the Seven Wonders of the World Remains.—It is a curious fact that only one of the "Seven Wonders of the World" has survived. This is the Great Pyramid of Cheops at Ghizeh.

An Old-World Cubit in America.—In *Ancient Egypt*, Part iv., 1922, Prof. W. M. Flinders Petrie directs attention to excavations made by the School of American Research at Santa Fé, New Mexico, where the measurements of buildings indicate a unit of 20.7 inches. This figure accords exactly to the well-known Egyptian cubit: 20.62 in the best early examples, 20.65 in later cubit rods, 20.76 on the Roman Nilometers. Babylonia had a rather longer type, 20.88 inches for the cubit of Gudea's plotting scales, and this was also the standard of Asia Minor, 20.6 to 20.9, with a mean of all of 20.63 inches. "How could this reach New Mexico? It was evidently Asiatic. We have evidence from weights of an Asiatic diffusion of a Babylonian original over India, China and Etruria. If the cubit similarly passed to China, it might thence reach North America. It has been already pointed out how the cross at Palenque (Southern Mexico) was in its detail of ornament derived from Italian crosses of about the eighth century, probably carried to China by the Nestorian mission. By the same route the Asiatic cubit may have passed over to the New World at some earlier period."

Holy Land Yields Egyptian Ruins.—The expedition excavating for the University of Pennsylvania at Beisan, Palestine, the Bethshean of the Old Testament, has unearthed substantial Egyptian buildings, with evidence of five centuries' occupation, and two large, clear monumental inscriptions of Seti I. and Rameses II., respectively. The inscriptions indicate military dispositions of known divisions of Egyptian troops and give references to neighboring cities on both sides of the Jordan. Beisan is a small town, near the Jordan, 55 miles northeast of Jerusalem. Seti I. was King of Egypt of the nineteenth dynasty, about 1366 B. C. He was the father of Rameses II.

Archæological Opportunities in the Near East.—Dr. William H. Buckler recently read a paper at the joint meeting of the Archæological Institute of America and the Historical Association in which he indicated the opportunities for exploration in the Near East, particularly in Anatolia. The best basis for a quantitative estimate of sites for research there seems to be the list of cities and towns in Anatolia which coined money between the fifth century B. C. and the second century A. D. The term Anatolia, as here used, covers all of Asia Minor lying west of a line running north from Alexandretta through Sivas to the Black Sea. A list of such ancient cities and towns having mints of their own works out as follows: In Lycia, Pamphylia and Pisidia, 95 towns; in Lycaonia, Isauria and Cilicia, 82 towns; in Phrygia and Galatia, 61 towns; in Bithynia, Paphlagonia and Pontus, 34 towns, and in Ionia, Lydia and Caria, 84 towns. Total, 356 towns. When deductions have been made, as well as a liberal allowance for towns of which we know the names but not the exact positions, there will still remain about 300 "virgin" sites of towns deserving excavation.

Miscellaneous Notes

Dynamos on the Dead Sea.—Plans for the electrification of Palestine by raising the level of the Sea of Galilee and harnessing the historic River Jordan, involving an initial expenditure of $10,000,000, are described in "Palestine—Its Commercial Resources with Particular Reference to American Trade," by Addison E. Southard, American consul at Jerusalem, just published by the Department of Commerce. The same project calls for the canalization of the Jordan Valley from the Sea of Galilee to the Dead Sea, where under irrigation, it is expected that copious crops of dates, rice, sugar cane, flax, and cotton can be produced. Provision for 2000 miles of motor highways, commercialization of the Bagdad-Cairo air route, traversing Syria, and agricultural credit banks are among the other innovations contemplated in the modernization of the Holy Land, as related by Mr. Southard.

An Actor's Invention Saves Many Lives.—The recent death of William Hanlon, the actor, at the age of eighty-seven, has a special meaning for the New York Fire Department, for it is to this member of the Hanlon brothers (six in number) that we owe the invention of the life net. More than forty years ago the brothers were doing a "stunt" called "A Leap for Life" when one of the brothers, Thomas, fell and was killed. William Hanlon then devised a rope-net to protect himself when he took his brother's place in the act. He showed it to his friend Hugh Bonner, then chief instructor in the New York Fire Department Training School, who at once seized onto the idea. The life-net in improved form is now carried to every fire in New York as well as in most other places. The old rope-net has given way to one of canvas, which remains taut under all conditions and has sufficient slack to act as a harmless break to the fall of the body. The canvas is stretched inside of a steel ring nine feet in diameter, and is fastened to the ring on thirty steel rods, each connected with a string. This serves to keep the canvas taut and allows the ten men to jockey the net into position under the falling person.

Burglary and the Post Office.—The business of burglary is constantly being made more difficult. The Post Office Department is securing 110 locking devices for installation on government-owned safes in certain small offices where considerable money is handled. This device is adjusted to the locking mechanism of the safe. When a burglar attempts to drill a hole for the insertion of nitro-glycerine the device locks automatically and no number of holes will permit of entrance by the burglar. After the device locks it is necessary to have an expert sent from the factory furnishing the lock to open the safe. The postmaster himself cannot get in the safe until the arrival of the expert. The new locking device will supplant the little pint bottle of ammonia which has been used for the last five or six years with more or less effect. The ammonia, in concentrated form, is placed in the safe where the force of the explosion is calculated to break the glass, thus releasing the fumes and forcing the yeggs to wait until the atmosphere clears before they can "lift" the loot. The interval of waiting, in a number of cases, has given time for local authorities, aroused by the explosion, to reach the scene before the departure of the bandits and either to effect their capture or frighten them away without having robbed the safe. In a few instances, the burglars, impatient to secure the loot, have been overcome by the powerful ammonia fumes and were found unconscious by citizens aroused by the explosion. The percentage of successful performance by the ammonia plan, however, has not been sufficiently satisfactory to warrant placing dependence upon it, and department officials, aided by inventors, are constantly seeking new safeguards to place around postal receipts and valuables.

The Dangerous Hour in London.—In London more accidents occur on Saturday than any other day of the week. The time favorable to accidents seems to be between 3:00 and 4:00 p. m. or much earlier than in the United States. The next most dangerous hour is that between 10:00 and 11:00 at night. This is not surprising as the traffic is heavy and poorly regulated at night. It is as much as your life is worth to cross the Strand in the late evening. It has been urged, not only in London but elsewhere, that an improvement of the street lighting would go far toward removing this danger.

The Service of the Chemist

A Department Devoted to Progress and Achievement in the Field of Applied Chemistry

Conducted by ISMAR GINSBERG, Chemical Engineer

Adhesive from the Soya Bean

THE base for an adhesive is obtained from soya beans or the seeds of other leguminous plants, by treating the beans or seeds so as to form a liquid pulp mass from which the fluid is extracted by pressure. In this way the oil is separated from the bean and is mixed with the fluid. The next step is to remove it from the latter. Then the residual liquid is curdled and the curd is separated, dried and powdered. This forms the base of adhesive compositions.

Alternatively the liquid pulp mass itself may be curdled after extracting the oil from it. The curd may be treated so as to extract any acid present before it is dried. The solution of the extracted base may be compounded with sodium fluoride and calcium hydroxide in water to give an adhesive preparation. This process is patented in British Patent No. 203,969.

Manganese Deposits in Java

INDICATIONS of manganese ore have been discovered in the Residency, Djokjakarta (Java) over an area of nearly two miles. It is undoubtedly a sedimentary deposit, and the layer has an average thickness of from three to four and a half feet, increasing in places to five and one-half feet. In the lower bed of the seam pyrolusite has been found which contains 50 per cent of manganese, but the upper bed is not so pure. By calcining, an export product can be made with 63 per cent manganese. Manganese ores also occur in the lake districts of Celebes. These are highly ferruginous, and on analysis shows 19.3 per cent loss by burning, 3.46 per cent SiO_2, 47.60 per cent Fe_2O_3, 24.09 per cent of Mn_3O_4, 1.18 per cent of NiO and 0.46 per cent of Cr_2O_3.

Uses of Anhydrite

ANHYDRITE is a mineral which occurs in considerable quantities in various parts of the country. It is usually found in gypsum mines and at the present time it is practically a waste material. It is reported, however, that the Bureau of Mines is busying itself with experimental work to determine the usefulness of this product. It is felt that the mineral has perhaps some use as a substitute for gypsum in the manufacture of portland cement.

Manganese and Plant Growth

CERTAIN elements that occur only in very small amounts in plant tissues would appear to play some definite part in the economy of the plant. According to the *Journal of Agricultural Research*, Volume 24, pages 781, 794, an investigation has been made to determine the effect of manganese sulfate on the growth of plants in water cultures with specially purified nutrient salts. The results indicated that the presence of manganese was essential to the normal growth of the plant.

Such plants as radishes, soya bean, cow pea, field pea and maize do not contain sufficient manganese for growth to maturity, though some have sufficient to maintain a normal development for the first few weeks. In the latter case experiments which were carried on for too short a time failed to reveal the essential nature of the manganese.

The lack of manganese affects the production of dry matter and brings about an etiolated condition of the young leaves and buds, suggesting that the element has a function in photo-synthesis and in the formation of chlorophyll. Experiments carried on in soil showed that manganese sulfate applied to acid soil caused a decrease in crop, whereas if calcium carbonate were applied in addition to neutralize the acidity increased yields were obtained. Soluble salts of manganese in acid soils may therefore be one of the causes of toxicity in such soils as exhibit toxic effects, an excess of manganese sulfate rendering a soil more or less sterile with respect to the growth of plants.

Improving Odor of Whale Oil

TO improve the odor of whale oil, the latter is treated with formaldehyde. It is advisable to add a little mineral acid to the oil while it is undergoing the formaldehyde treatment. The process is carried out at the ordinary temperature or if the mixture of oil and formaldehyde is heated gently for a prolonged time while being constantly agitated. The additional products, which the formaldehyde makes, settle to the bottom of the oil, and are removed. These constitute some of the impurities which give the oil its bad odor. The excess formaldehyde is then removed by passing through a current steam or by the influence of various oxidizing agents. This process is patented in German Patent No. 362,281.

Rubber Latex in Sizing Paper

THERE has been much controversy on the value of rubber latex as a size for paper. Some authorities have held that it is worthless and others have argued that it is very valuable, strengthening and generally improving properties on the paper in which it is used. The latest work on this problem is published in the journal, *Paper*, which gives a translation of a report of certain work performed by two Dutch chemists in the governmental testing laboratory.

The conclusion reached was that the introduction of small proportions of rubber latex into the beater with the pulp served to increase the strength of the paper made from the pulp. About three per cent of rubber latex appears to give satisfactory results. A comparison was also made of the sizing properties of rubber latex in comparison with rosin size. It was found that rubber latex is not so good a sizing agent as rosin size.

Non-Crystallizable Syrup

CANE syrup as now produced from varieties of sugar cane, and other syrups rich in sucrose frequently contain so large a proportion of sucrose that more or less sucrose separates in the form of crystals in the syrup on standing after cooling. The presence of such sugar in the syrup injures materially its commercial value.

The United States Department of Agriculture has found that by the use of either fresh or air-dried baker's yeast, to invert a portion of the sucrose present in the syrup, the sucrose content can be reduced sufficiently so that separation of crystals does not occur. The amount of inversion required varies with the density to which the finished syrup is reduced, and with the temperature of storage of the finished syrup. The greater the density, the greater the degree of inversion, and the degree of

inversion required is also greater if the syrup is to be kept at winter storage temperatures. For example, in the case of cane syrup of 39.3 degrees Be. density the degree of inversion required for storage at 32 degrees F. is approximately that corresponding to 60 purity of the syrup.

In carrying out the process the cane sugar is mixed with fresh baker's yeast in the proportion of approximately 0.02 per cent of the weight of the cane syrup. It is then kept between the temperatures 50 to 60 degrees C. and mixed with fresh bakers' yeast in the proportion of about 0.02 per cent of the weight of the cane syrup. It is then kept within the temperature range specified until the desired degree of inversion has been accomplished. It is then heated to boiling and allowed to cool, thus completing the process. Usually from 15 to 60 hours is required, depending on the amount of yeast used, the density of the syrup, its temperature, and the amount of inversion required. The larger the amount of yeast used, the greater the rate of inversion of the sucrose. The rate of inversion of sucrose decreases with increasing density of syrup and increases as the temperature rises. This process is patented in United States Patent 1,467,599.

Tung Oil Trees Grown in Florida

THE importance of tung oil or China wood oil as a paint and varnish raw material and the remoteness and uncertainty of supplies have led to efforts to acclimatize the tree which bears the nut from which the oil is extracted. From ten seedlings planted 11 years ago at Gainesville, Fla., by the Florida Experiment Station in cooperation with the United States Department of Agriculture, sufficient experience has been gained to warrant the belief that the tree can be cultivated in Florida.—*Chemical Age.*

Specific Heat or Coal and Composition

THE conclusions reached after a series of investigations on this subject as they have been reported in the *Journal* of the Society of Chemical Industry are as follows:

1. The specific heat of coal in general lies between 0.2 and 0.4 and depends on the amount of water that is contained in the coal.
2. For purposes of comparison it is essential that the moisture content of the coal be stated.
3. As far as can be seen from the results given the specific heat of the contained water is approximately equal to that of the free uncombined water.
4. The specific heat depends on the nature and general composition of the coal. Coals of the same class and of similar percentage composition possess values of the same order for their specific heat when reduced to the dry ash-free basis.
5. Increase in the carbon-hydrogen ratio causes a decrease in the specific heat, and in general with increase in volatile matter there is a corresponding rise in specific heat.

Aluminum Salts from Alunite

THE Bureau of Mines at the experimental station in Berkeley, Cal., has been carrying out experiments on a new process for the conversion of alunite, a mineral which consists chiefly of potassium and aluminum sulfates, into alum and aluminum sulfate. An apparatus for conducting the experiment was constructed to have a capacity of 100 pounds per charge. The process consists in making the alunite soluble, then the solution is treated for potash alum and a good grade of iron-free alum is obtained by direct crystallization.—*Oil, Paint and Drug Reporter*, April 7, 1924.

Chemistry Notes

Food Product from Skimmed Milk.—The concentration of buttermilk, by evaporating part of the water in a vacuum pan, is now a well-established commercial enterprise. If the concentration is carried to a point at which the finished product is a semi-fluid, pasty mass it is known as concentrated buttermilk and is used extensively as poultry food. In making semi-solid concentrated buttermilk from buttermilk obtained by churning sour cream, the casein is already precipitated and the precipitated curd broken up into small particles which have very little tendency to conglomerate when the buttermilk is heated in the pan. Consequently when buttermilk is condensed the finished product is made of very small separate particles and has a homogeneous, smooth appearance. On the other hand if skim milk which has the same chemical composition as buttermilk is soured by the addition of acid, or the growth of acid-forming bacteria, and is subjected to the condensing process the precipitated curd is conglomerated and the finished product consists of tough lumps and curd and whey. The semi-solid concentrated buttermilk is preserved by the acid which, in the finished product, is quite concentrated. It is necessary that this acidity should be sufficiently high to prevent the growth of bacteria. The ordinary lactic acid bacteria do not always produce sufficient acid in the skim milk to give the required concentration in the finished product. The Department of Agriculture finds that by using bacteria of the so-called lactor-bacillus type, a much higher acidity can be obtained and the finished product has a better keeping quality; also that when the curd after precipitation is thoroughly broken up mechanically, the precipitated, sour milk may be condensed in a vacuum pan without agglomeration of the curd and a satisfactory product is obtained. This is accomplished by agitation or more satisfactorily by forcing the precipitated milk through an emulsifier or homogenizer. In this process the milk is forced by high pressure through a small orifice so that the curd particles are thoroughly broken up. By this method the curd particles of the soured milk acquire the same physical conditions as the particles of curd in churned buttermilk. This process is also useful in making buttermilk powder, which is simply a continuation of the process of evaporation, although a different type of machinery is necessary for removing the water after a certain concentration is reached.—*Chemical Age of New York.*

New Swedish Metal Furnace.—A Swedish inventor has invented a thermo-electric accumulator furnace which can be heated and adjusted accurately to any degree desired up to 1300 degrees and can thus be used with advantage for heating metals, especially iron and steel for manufacturing processes. It can be used, for instance, in the hardening of colorless window glass on electric welding forging. The furnace has been used for experimental purposes.

Utilization of Samba for Paper Making.—Samba, whose botanical name is Triplochiton, sceloxylon, occurs in Guinea the Ivory Coast, Dahomey and the Cameroons and has been investigated for use in paper making. The wood contains 60 per cent of cellulose and 39 per cent of lignone, but only 33 per cent of cellulose was obtained in the technical tests, the paper produced being of the common type. When bleached, the pulp was a dull white, slightly rough to the touch and fairly supple. Resistance to tearing, rubbing and other tests was mediocre. Very thin sheets can be obtained, the felting power being 0.015. With energetic treatment the lignone is easily eliminated, and the wood seems well suited for paper making.—*Jour. Soc. Chemical Industry.*

Ammonium Sulfate from Clay.—The Bureau of Mines has been studying the problem of the conversion of sulfate of alumina into clay. A special study of the dissolutions of clay in various strengths of sulfuric acid and at various temperatures has been made. Different clays show quite large individual differences in their reaction with acid. The different types of material so far tested include: California fireclays, an Idaho kaolin, a Georgia kaolin, a Missouri diaspore, a California bentonite, a Dakota bentonite, and a Utah alunite. A fuller's earth was also tested, but was found too low in alumina to be considered. During the present year liquid sulfur dioxide and water in sufficient quantities to make strong sulfurous acid will be tested under pressure and heat for decomposing clays, as it promises to be much easier to purify the solutions and recover aluminum oxide from the aluminum sulfite solution than is possible with sulfuric acid and aluminum sulfate solutions.

New Washing and Bleaching Agent.—A new washing and bleaching compound, which has been put out on the market in Germany under the name of "Zauberin," is found to contain principally para toluolsulfo sodium amide. The action of this substance is quite the same as that of ordinary bleaching powder and the hypochlorites. It removes stains and bleaches, but it does not have the injurious action on the fiber as do the chlorine bleaching agents. The use of this substance is recommended not only to regular laundries but to the home laundry as well, and it is said that wonderful results can be obtained with it, the clothes are washed perfectly clean and white without much rubbing, etc., and with no injury to them. For further details see *Leipziger Monatschrift fuer Textil-Industrie,* 1923, No. 10, page 224.

Absolutely Rust-Free Chrome Iron.—The manufacture of an absolutely rust-free chrome iron, possessing a silver-white color and all the properties of soft iron has been carried out to a successful conclusion by a Swedish concern. Swedish iron was used for this purpose which was mixed with a certain amount of ore coming from South Africa. It is figured that a roof which is covered with such a roofing will cost only half again as much as one made from galvanized iron. The new alloy roofing does not, of course, require any painting to protect it from rusting. A test is being made in a newly constructed boiler house in Sweden of which the roof has been made from the new alloy iron.—*Chemiker Zeitung,* 1924, page 118.

Treating Leather with Rubber Latex.—In British Patent No. 209,811 there is described a process of treating leather with rubber latex in order both to waterproof the leather and strengthen the same. The leather may be treated with the latex either before or after tanning. The latex is used in the preserved condition, which is attained by the addition of such substances as ammonia, which prevents coagulation. Sulfur, glues, filling materials and coloring agents of various sorts may also be added. The latex may be sprayed upon the leather which is placed upon racks in a closed heated chamber, or the materials may be mixed in a revolving drum in an atmosphere of ammonia.

Fire-Retarding Paints.—There is probably no such thing as a "fireproof" paint, but the possibility of designing paints which will minimize to some extent the effects of fire and retard its spreading is an important problem in connection with the painting of wooden buildings. The use of paints containing borates, ammonium phosphate, etc., has frequently been suggested, but such paints have the objection that they weather badly, owing to the presence of such water-soluble and reactive substances. It has been reported that the most satisfactory line to work on for such paints is to use a paint containing a maximum of pigment to reduce the inflammability of the oil, the pigments themselves being entirely mineral and free from organic substances. This reduces one in practice to paints made with earth colors reduced with barytes; but the possibility of devising a paint vehicle which will be noninflammable, and at the same time stand exposure to weather, is very remote.—*Oil and Color Trades Journal,* Dec. 29, 1923.

Apple By-Products as Stock Foods.—As only a small part of the moist apple pomace produced each year by cider and vinegar-makers can be profitably utilized in the fresh condition or ensiled, its preservation by dehydration is recommended. Because of its property of absorbing large quantities of water, dried apple pomace is made and used as a source of succulence for the winter feeding of dairy cows. Pound for pound of dry matter consumed the moistened pomace seemed to be slightly more efficient as a milk producer than corn silage. Dried apple pectin pulp, the dried material remaining after the extraction of sugars, pectin and other water soluble substances from apple products, seemed to be intermediate between corn silage and beet pulp as a source of succulent food for cows. The valuable extractives of apple pomace, sugars and pectin, are utilized as ingredients of food for human beings. For further details see U. S. Department of Agriculture, Bulletin No. 1166, July 26, 1923.

Lead gives light when darkness comes

BLACK clouds hide the midday sun. A storm is about to break over the city. In every office and home people get up and turn on electric lights.

In the emergency the power plant must supply electricity up to its capacity. But only two of the generators are running, and it takes time to put the others in operation. Where is the additional electricity to come from?

Man turns to lead for aid. In the power plant an electrician throws a switch that turns on the current from many storage batteries. These batteries, made mostly of lead, provide the extra current until other generators are started.

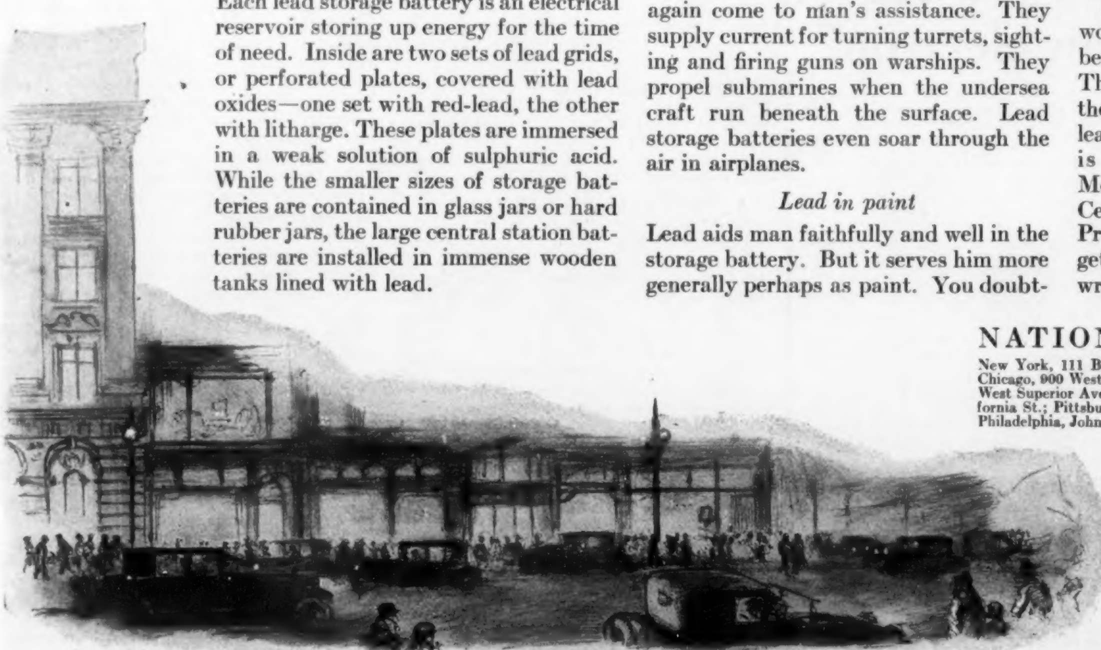
Millions of pounds of lead used

Lead is serving you in storage batteries everywhere. At home, on trips by land and sea or through the air, in peace and war, these lead batteries have become an essential part of the nation's life—the life of each of us.

Storage batteries in this country in use in radio sets, automobiles and central station power plants alone contain many millions of pounds of lead. The amount of lead used in a single storage battery ranges from a few pounds in the smallest to several hundred thousand pounds in the largest battery.

What's inside the storage battery?

Each lead storage battery is an electrical reservoir storing up energy for the time of need. Inside are two sets of lead grids, or perforated plates, covered with lead oxides—one set with red-lead, the other with litharge. These plates are immersed in a weak solution of sulphuric acid. While the smaller sizes of storage batteries are contained in glass jars or hard rubber jars, the large central station batteries are installed in immense wooden tanks lined with lead.



Lead storage batteries supply electricity for telephone, telegraph, and wireless communication. They furnish electrical energy for self-starters, lamps, and ignition systems in millions of automobiles. They supply current for the ignition systems of tractors on many of the 6,000,000 or more farms in the country and gas trucks in every part of the land.

Set of storage batteries reserved for emergency lighting needs in a central power plant

Lead storage batteries propel street-cars, electric industrial and pleasure vehicles, mine locomotives, and electric fire engines. They operate drawbridges, railroad switches, and signals.

Lead at sea and in the air

For yacht lighting and for motor-boat lighting and ignition, storage batteries again come to man's assistance. They supply current for turning turrets, sighting and firing guns on warships. They propel submarines when the undersea craft run beneath the surface. Lead storage batteries even soar through the air in airplanes.

Lead in paint

Lead aids man faithfully and well in the storage battery. But it serves him more generally perhaps as paint. You doubtless know that white-lead is the standard paint for wood and non-metallic surfaces. Red-lead, another lead pigment, is the standard paint for metal to protect it against the attacks of rust. You see red-lead everywhere—on skyscraper skeletons, bridges, gas tanks, ships, on metal construction wherever used. It saves the covered surface and hence the entire structure from rapid deterioration and eventual destruction.

"Save the surface and you save all"

Producers of lead products

Dutch Boy red-lead is the name of the pure red-lead made and sold by National Lead Company. It comes in paste form which can be tinted to any dark color.

On every keg of *Dutch Boy red-lead* is reproduced the picture of the Dutch Boy Painter shown here. This trademark guarantees a product of the highest quality.

Dutch Boy products also include white-lead, linseed oil, flatting oil, babbitt metals, and solder.

National Lead Company also makes lead products for practically every purpose to which lead can be put in art, industry, and daily life. If you want information regarding any particular use of lead, write to us.

If you wish to read further about this wonder metal, we can tell you of a number of interesting books on the subject. The latest and probably the most complete story of lead and its many uses is "Lead, the Precious Metal," published by the Century Co., New York. Price $3.00. If unable to get it at your bookstore, write us or the publishers.

NATIONAL LEAD COMPANY

New York, 111 Broadway; Boston, 131 State St.; Buffalo, 116 Oak St.; Chicago, 900 West 18th St.; Cincinnati, 659 Freeman Ave.; Cleveland, 820 West Superior Ave.; St. Louis, 722 Chestnut St.; San Francisco, 485 California St.; Pittsburgh, National Lead & Oil Co. of Pa., 316 Fourth Ave.; Philadelphia, John T. Lewis & Bros. Co., 437 Chestnut St.

Science Notes

Dwarf Dinosaurs from Mongolia.—In a recent American Museum publication called "Novitates," Professor Henry Fairfield Osborn and Dr. W. K. Gregory describe some of the first fruits of the Museum's Mongolian explorations. Two little dinosaur skeletons articulated and nearly complete, but only three or four feet long are among the prizes secured, and the skull and jaws of a third small form. These three specimens come from three distinct basins of Cretaceous formations in central and western Mongolia. Their exact affinities are not yet determined, but it appears probable that they are in a general way primitive ancestors of some at least of the gigantic and highly specialized dinosaurs that flourished at the end of the Cretaceous period. The skull is considered by Dr. Gregory as ancestral to the great Horned Dinosaurs, or Ceratopsia. The two skeletons may perhaps be ancestors of other kinds of giant dinosaurs and are certainly primitive little reptiles somewhat of the proportions of the iguanas, but with longer and larger limbs and with the dinosaurian skull construction.

A Mule Murders a Freak Cow.—Sometimes natural history notes become more interesting as news than as science. During the winter circuses and freak animal shows lay up and in this period many accidents happen. A tragedy recently occurred at Mineola, L. I., when the left hoof of "Jack Johnson," a monkey-faced mule, killed "Rosie," prize cow. "Rosie," famous because her heart was in her throat, its pulsations plainly visible, was wandering about, when "Jack Johnson" began to lash out with his hoofs. One hoof struck her in the neck, just above the heart, and she dropped. When the trainer reached her she was dead.

The American Association of Museums.—This association has headquarters at the Smithsonian Institution. The object of the organization is to promote the welfare of museums, to increase and diffuse knowledge of all matters relating to them, and to encourage helpful relations among museums and those interested in them. The association has recently been changed radically for the better. Prof. Charles R. Richards is the director.

A Monkey Ranch for the Pasteur Institute.—The French Pasteur Institute will fence in a large area in the African forest where such primates as they need for their scientific experiments can be secured in healthy condition.

Elk's Teeth as Emblem.—Congressman Albert H. Johnson recently spoke to the American Game Protective Association. Mr. Johnson said that he was a member of the Elks and said that the order should discourage the purchase of the elk teeth by its members. "There are more than a million elk teeth on the market," said Mr. Johnson. "Some of them have been obtained by poachers and the rest made from celluloid on the east side of New York. The decrease of elk is not due to big game hunters. It is from the sneaking, sure-shot poacher, who picks out the bulls of the herd and drops them for two teeth at $5 each.

Fear for the Antelope.—The American antelope is threatened with destruction. There are probably not more than 3000 antelope remaining in the United States, according to a statement, and the total number in the Yellowstone Park is about 350.

A Memorial to W. H. Hudson.—A fitting memorial to W. H. Hudson, British naturalist, sometimes known as England's John Burroughs, will probably be erected in the form of a statuesque drinking fountain for birds which are not within access to streams where, according to a nonsensical custom, such memorials are usually placed. By the will of Mr. W. H. Hudson, the residue of his property, more than £7500, is bequeathed to the Royal Society for the Protection of Birds "to be used exclusively for the purpose of procuring and printing leaflets and short pamphlets suitable for the reading of children in village schools . . . each is to be illustrated with a colored figure of a bird, the writing is to be not so much 'educative' or 'informative' as 'anecdotal.'"

Ants Eat Farm House.—State entomologists of Illinois are investigating the destruction by white ants of a two-story farm house at Morris, Ill. In removing stucco it was discovered that the ants had completely honeycombed the woodwork of the structure, starting at the foundation and going to the roof. This often happens in tropical countries.

An Insect Rogues' Gallery.—The American Nature Association is organizing at Washington what we might call an "insect rogues' gallery," and while insects can no more be suppressed than criminals, still their ravages can be curtailed by a knowledge of their migrations and the best methods of combatting them.

To Improve Reindeer Herds.—The possibility of improving the grade and weight of the reindeer in Alaskan herds by crossing them with caribou is being considered by the Biological Survey, United States Department of Agriculture. A reconnaissance has been made in Mount McKinley National Park to determine the best locality for capturing, later in the season, a supply of young caribou bulls to be used in the breeding experiments.

Whale Extermination.—The whale faces extermination, for the whaling industry is far from being decadent as we would be led to suppose from the New England decline. The Greenland variety is practically extinct so that the hunt is now almost entirely in southern seas. The principal whales now caught are the fin whale, the blue whale and the sperm whale. A fair-sized whale will yield a small fortune in whalebone alone, to say nothing of 30 tons of oil.

Self-Loading Repeating Crossbow.—The invention of the Chinese self-loading, repeating crossbow has been credited to General Chu-ko-Liang (181-234 A. D.), but early records show that self-loading crossbows are referred to in Chinese literature several centuries before Christ. In all probability this efficient weapon is not a Chinese contrivance, but belongs to the culture of the Lolo and Maio-tzu, aboriginal tribes in the southwest and south of China. Their national weapon is still the crossbow, and they have influenced Chinese culture to a certain degree since oldest times. In the Chinese collection on the third floor of the American Museum of Natural History are to be found some excellent examples of implements of warfare, including a well-preserved repeating crossbow. The weapon consists of a wooden arm about a foot and a half in length. In this is a perforation through which the bow passes. On the stock there is affixed a magazine holding from seven to ten small darts which are be shot off one after another in quick succession. On the arms there is a lever connected with the magazine through which passes a string of neat leather. In moving this to and fro the crossbow may be shot several times consecutively, the darts sinking by their own weight into the catch. The principle on which the arrow case is constructed tallies with the magazine mechanism of our modern rifle, first constructed in America in connection with the Winchester rifle in 1867. In Peking house owners still make use of the crossbow to scare away burglars.

Whaling as a Sport.—Wealthy sportsmen, discouraged by the scarcity of big game, are outfitting three whaling vessels at Seattle for midwinter cruises in the north Pacific; the black or beluga whale is the chief object of their attention. Last winter such an expedition was highly successful. Two gunners in each catboat were armed with guns no heavier than high-powered rifles, throwing "infant harpoons." The beluga whale is about 25 feet in length, and the sale of hides more than paid expenses. The vessels are equipped with wireless to catch storm warnings from shore stations. The whale hunt is said to provide a distinctly new thrill.

Wild Beasts as Baggage.—Mr. R. L. Ditmars tells an amusing story of shepherding wild animals from San Francisco to New York. Among them were pythons, pigmy water buffalo, and two orang-utans. Mr. Ditmars was kept busy protecting the apes from changes in temperature. The larger orang had a sunny warehouse room, but shivered at night; being given an army blanket, he soon learned to wrap up in it. The smaller orang lived in his master's room at the hotel, "upon reluctant permission from the management." By the kind cooperation of the railroad all these specimens were transported on the Overland Limited as baggage; four days' travel brought them safely to their new home.

Making Tough Meat Tender.—The use of papaya or a powder from the dried fruit of the papaw to make tough meat tender is not considered desirable by the Department of Agriculture, whose Bureau of Home Economics has conducted a series of experiments in this line. They find that while the leaves in crushed form do make the meat tender they also give it a decided bitter taste.

A New Paper Source.—An English paper mill is trying out wheat straw as a source of material for paper making. While we have, of course, had straw paper, still this is a different proposition. The danger of this raw material is fermentation in storage.

A Twelve-Headed Doll.—At a recent toy fair held in New York City dolls were shown with from seven to twelve heads with a wardrobe of seven to twelve dresses. This gives a doll and a dress for every occasion. There were 175 exhibitions at the fair.

Sandals at Westminster Abbey.—The Office of Works recently submitted the floor of the chapter house, Westminster Abbey, to a special treatment, which has resulted in reviving some features of the decoration, such as lions and fishes. The pathway has for years past been protected by oilcloth, but this has been removed, and sandals have been provided for the use of visitors. Fifty pairs are kept at the entrance.

An Expensive Model.—An elaborate model of the Panama Pacific Exposition of 1915, made by Alfred Lee of San Francisco, has been placed on the market. The price asked is $50,000. The model covers an area of seven by twelve feet, weighs eight hundred pounds and is wired for either night or day illumination.

The Thermometer and the Human Body.—If it were possible to so inclose a man that he could continue to breathe and no heat could escape from his body, he would die within a short time, states Dr. T. T. Read, supervising mining engineer, Department of the Interior, and F. C. Houghten, of the American Society of Heating and Ventilating Engineers, in Serial 2554, just issued by the Bureau of Mines. The normal temperature of the human body is about 98.5 degrees F. and whenever work is done by the muscles, indeed even when sitting still, the normal bodily processes generate heat which must be given off, otherwise the body will become overheated and a number of bad effects will result. In a series of experiments made at the Pittsburgh Station of the Bureau of Mines, it was found that a dry-bulb and a wet-bulb temperature of 112.5 degrees F. could be borne for only 35 minutes, even when the subject was at rest. A wet-bulb temperature of 100.4 degrees F. (dry-bulb 157 degrees F.) could only be tolerated for 45 minutes. Under such conditions the bodily temperature rises as much as 4.5 degrees F. above normal and the pulse is accelerated. Very uncomfortable sensations are felt when the pulse rate exceeds 135. The human body, like any other internal combustion engine, must be cooled in order to function properly.

Catnip Lure.—The Biological Survey of the Department of Agriculture developed a lure a number of months ago and is now using it extensively in the Western States in trapping cougars and bobcats, which prey on live stock and game. The Department, unable to find any company which manufactured catnip oil, grew catnip, and extracted the oil, getting a little over a pound to the ton of the green plants. The practice now is to mix the catnip oil with oil of petrolatum, which prevents the scent from escaping too rapidly. This combination is now used regularly by Government hunters.

Advertising Dangerous Animals.—In Heidelberg they do a very wise thing; they placard any dangerous animal with signs which read like this: "Danger—this animal bites."

Safety Razors Increasing.—It would appear from the report of a large safety razor company that the use of this article is on the increase. Sales during 1923, including those of subsidiaries, were 7,798,781 razor sets, 29,061,634 dozens extra blades, compared with 3,420,895 sets and 24,082,970 dozens extra blades in 1922.

A Pond Drops Into an Iron Mine.—Forty-two miners perished when the bottom fell out of a small pond and flooded the workings of an iron mine near Crosby, Minn. Only seven men were able to gain the safety of the shaft and ascend to the surface. North of the mine lies Island Lake and between the mine and the lake was a small pond and it was the water from this which poured into the mine when the bottom dropped out.

Toothache in the Movies.—An aching tooth in action is the last thing we should expect to find in the movies. "The Ivory Cross," an English society for the protection of teeth, have had a film produced which shows a throbbing nerve.

Casein and Its Products

MILK has been called the ideal food. It contains all the ingredients that are necessary for bodily nourishment and growth. It is easily digested and assimilated, and it forms the mainstay of the nutrition of infants and the sick of all ages.

There is no need of describing milk from this standpoint, for it is familiar to all. Similarly it is commonly known that cheese is made from milk, the milk being curdled by one means or another, for example, by the addition of the ferment, known as rennet. Some of us may have watched our mothers make cheese from sour milk, and it may have struck us that the pasty mixture, that is first obtained when the whey is removed from the solid matter that has been precipitated from the milk, was of a sticky nature. At any rate it may have been seen that the curd stuck together pretty well and made a fairly compact mass.

But it probably did not occur to us that this property of cheese, or better, of milk curds, could be applied to useful purposes in a variety of ways which are far afield from the traditional use of milk and cheese as food. It could hardly be supposed that a substance, which is as highly polished as marble and which possesses considerable strength, could be made from it. In fact this particular product looks like a veritable stone. Then again, it could scarcely be expected that it would be possible to make from this substance a composition that could be formed into a fountain pen.

But these things have been done and the curd substance in milk has been employed for other industrial purposes as well. These products are known as casein products. Casein is the name given to the protein matter in milk, which is held in the state of a colloidal suspension in the milk and which is precipitated when agents are added or are produced in the milk to disturb the colloidal status of the same. Thus when milk sours, the sugar in the milk, known as lactose, ferments due to rise in temperature and to the action of bacteria, with the formation of lactic acid. As soon as sufficient of this acid is present in the milk, the colloidal condition of the milk solution is destroyed and the colloid, casein, is precipitated. In milk there is approximately 3 per cent of casein and about one-half per cent of albumin besides fat, sugar, mineral matter. About seven-eighths of the weight of the milk is made up of water.

The Making of Casein

Of course casein can be prepared from the whole milk, but this product possesses far too valuable constituents to be used for this purpose. Hence the ordinary practice is to remove these valuable constituents which are mainly the butter fat by centrifuging the milk. In the machines that carry out this process the milk is subjected to a very rapid rotary motion, and the cream or the portion of the milk which is richest in fat, rises to the surface and can be skimmed off. What is left is known as skimmed milk, and this is the one of raw materials that are employed in the manufacture of casein. Another is buttermilk. It must be remembered that casein is never dissolved in the milk but is held in it in the state of a colloidal dispersion.

When the milk is boiled or warmed, the condition of the casein in it is not changed, but it is precipitated, as has been indicated, by the addition of acids or by means of the ferment, rennet. The precipitated casein is quite a different substance, as far as physical properties are concerned, from the original casein in the milk. It is no longer miscible with water and when it is dried it forms a crumbling, horny mass. It dissolves in alkalies and strong acids. The differences between the original casein and the product recovered by precipitation has led to the belief that a modified form of casein is present in the milk and not the casein as we know in the form produced from milk.

Rennet, which is the ferment sometimes used in the coagulation and precipitation of the casein in skimmed milk, is an enzyme which is produced by special glands in the stomachs of many animals. It is particularly plentiful in the young animal. The rennet that is used in the making of cheese is obtained from the calf's stomach. It is said that one part of rennet possesses the power of precipitating one hundred million parts of casein.

The apparatus that is used in the casein plant is fairly simple. A large pan or system of pans is employed. These are arranged so that they can be heated and in some cases they are built into the brickwork of a furnace which is heated with wood. Another type of pan possesses a double bottom through which steam is introduced for heating. Hot water may also be employed for this purpose. The pans are usually made of copper. Besides these pans, filter presses, tanks, drying and grinding apparatus are employed.

The skimmed milk is introduced into the pans and then its temperature is brought up to the proper point by one or another of the means described. At the proper temperature it is treated with rennet or acid. No immediate change takes place but after a while the milk begins to curdle and soon thereafter precipitation of the casein is complete. At a temperature of 95 degrees Fahrenheit one part of good rennet is sufficient to curdle ten thousand parts of milk within a period of forty minutes. Two parts of the rennet will effect the same change in half the time or twice the change in the same time.

After the rennet has been used once, it loses its power almost entirely. Hence it is necessary to renew it frequently. Furthermore the stronger the action of the rennet, the sooner the casein is thrown down and the more powerful the contraction of the curd and the larger the volume of the whey expressed. When rennet is employed as the coagulating agent, it is very important to watch the quality of the ferment as well as the quality of the milk and the conditions under which the process is carried out, as the quality of the casein will depend on these factors.

The chief products of this coagulation of skimmed milk are the casein curd and the whey. The whey contains the soluble salts of milk and some finely divided curd, lactic acid, etc. The whey proper is used as a beverage, in baking, for feeding pigs, and also for the recovery of the milk sugar that it contains. When the curd is to be used for technical purposes, it must be freed from the whey by washing with cold or hot water.

Buttermilk is an important raw material in casein manufacture. It is coagulated by acid and the whey is removed by settling, centrifuging or pressing the curd; the latter is washed with cold water which hardens the curd and makes it easier to handle. The number of washings that are performed on the curd is important, for thorough washing is required to remove the acid that is used in coagulating the skimmed milk or buttermilk. This use of acids in place of rennet for coagulating the milk cheapens the manufacturing process.

After washing, the curds are pressed into blocks or forms. These forms are placed in a press and pressure is applied to a stack of them into which the wet casein has been packed. The curds are removed after remaining in the press over night. The next step is to grind the curd. A fine mealy curd is obtained when the grinding is properly carried out, and the ground product is then spread on drying trays and is permitted to dry thoroughly and quickly. The drying of the product

is carried out in tunnel dryers where a current of air is passed over the product. The time of drying depends on three factors; the condition of the curd, the uniformity of its spreading on the trays, and the volume and temperature of the air passing over the curd. The drying temperature is 134 degrees Fahrenheit and is found to have no bad effect on the casein. The casein that comes out of the drier is in a fine-grained condition and breaks up readily. It is removed from the trays and then ground and screened. The finished product is then packed into burlap bags and if kept in a dry place, it will keep for several months.

The yield of casein from buttermilk, depending on the condition of the milk at the time of coagulation, is from 2.8 to 3.1 pounds of the dry product to one hundred pounds of milk.

In the manufacture of casein from skimmed milk there are but few changes in the process, which need not be discussed here. It should be mentioned that the manufacture of casein from skimmed milk is the simpler method of the two and as it is possible to concentrate the skimmed milk at some central place, the green curd can be made at the same point and then shipped to a central drying plant or to the casein manufacturer.

Uses of Casein

Commercial casein is a whitish powder, sometimes possessing a yellowish cast especially when it is prepared by the use of sulfuric acid. The average composition of the substance is: water, 10.38 per cent; dry substance, 89.32 per cent. This dry substance contains 1.89 per cent of fat, 79.45 per cent of pure casein and 6.51 per cent of ash. Pure casein powder is absolutely white and does not contain any ash.

One of the most interesting uses to which casein is put is in the manufacture of all sorts of articles, possessing most varied uses, by mixing the casein with other materials which render it insoluble. The process, which was initially of foreign origin, consists in forming an insoluble compound of casein and formaldehyde. The product is obtained in large blocks and is also prepared in solid, horny plates and bars, which form a perfect substitute for ivory, ebony, horn, tortoise shell, celluloid, coral, and the like. This product has been called galilith.

It is possible to fashion this substance, and other similar preparations made from casein as a base, into all sorts of useful articles, as varied as a fountain pen and a teething ring. These products are perfectly odorless and hard; they can be dyed or colored in all shades, and their most important advantage is that they can be very easily manufactured by stamping the warm sheet of casein composition, the article hardening on cooling to retain the exact shape it was given while hot. There are innumerable articles of every-day use that can be and are manufactured from this product, such as combs, cigar holders, household fittings, etc.

Another very important use for casein is in the preparation of adhesives or casein glues. It is said that casein glues were used by the early Phoenicians and Egyptians in making articles of daily use from wood. Casein glue has been found in the mummy cases that have come down to us from them. The Romans used casein glue for building their great war galleys. It is strange, however, that in spite of this ancient evidence of the value of this substance as an adhesive, it was not until the World War that any real development of modern casein glues took place. During that time there was a great demand for a waterproof glue for many purposes and particularly for the manufacture of air-craft. This turned the attention of chemists and technologists to casein. After they had experimented with it for a short time they found that it possessed superior properties as a waterproof adhesive and, in fact, as a general adhesive for all purposes.

The uses to which casein adhesives have been put since then are very numerous. It is used on airships, and the American round-the-world fliers, who have just completed their circuit of the globe, used machines the plywood of which was glued together with casein. Casein is also employed in piano making, in ship building, in the manufacture of automobile bodies, in the manufacture of furniture, refrigerators and kitchen cabinets. Doors, stiles, rails are made with its aid. Trunks and wall boards are manufactured with casein adhesives. It is employed in the building of cars, wheels, billiard tables, outdoor signs, dolls, toys; it finds a use in cooperage and in the manufacture of rattan chair-seats. It is one of the few adhesives that will hold together very resinous woods, such as pitchpine, cypress and oily woods.

Another important use for casein is in the manufacture of paints, which are known as casein paints. Casein paint is a cold water paint and is excellent both for indoor and outdoor use. Casein possesses the property of combining with various substances and rendering them more or less insoluble on exposure to air. Although this property of casein has been known for some time, it is only comparatively recently that it has been applied in making paints. It is said, however, that some old paintings have shown the presence of casein on analysis, indicating that its advantages along these lines were realized in fairly early times. Casein-lime paint, what might be called casein-whitewash, is much more permanent than ordinary whitewash. Furthermore casein has also been used in paints containing linseed oil, petroleum, etc. Casein paints dry quickly with a dull or "matt" surface and are easy to handle. Pigments may be added to color the paint. Casein enamel paints are also made and give a glossy surface instead of the matt surface of the ordinary casein paint. There are really an extremely large number of paints that are made with the aid of casein, each possessing certain peculiar properties of its own. Numerous patents have been taken out on paint and varnish compositions that contain casein.

An interesting paint composition containing casein has been made in Austria. This preparation possesses disinfectant properties and is called formolactin. It is intended for painting on paper or other like material to render it washable, waterproof and dustless. The paint is made from a concentrated solution of casein and formaldehyde. This type of paint is recommended for painting bedrooms, hospital wards, smoking rooms and the like.

Playing cards are sometimes made by coating the paper with a mixture of satin white, which is precipitated calcium sulfate, and an alkaline solution of casein. In this connection it must be mentioned that casein is used to a large extent in the manufacture of coated papers, especially highly calendered papers that are employed for high-grade printing and engraving. Such papers are absolutely waterproof and will hold the ink lines without blurring in fine printing. At the same time the coating is absorbent enough to take and hold the colors from the electrotype. Casein is said to give better results in this particular application than any other sizing material known.

Another important use for casein is in the printing of calico. It is an ingredient of the printing pastes that are used in this process. Furthermore a solution of casein in lime water is employed for the purpose of impregnating cotton and linen fabrics to render them more ready to absorb dyestuffs. Glutin, which is a size for dressing curtain fabrics is made from casein and sodium tungstate.

Sometimes it is desirous to give fabrics a metallic finish. Casein is used in admixture with powdered metal for this purpose. Casein is also employed in waterproofing processes on textile fabrics, and finds application in the loading of

silk. An interesting use is in the manufacture of artificial silk, which is accomplished by dissolving the casein in an alkali and treating the same with acetone, which causes the separation of a pure white flocculent precipitate. This is removed and the liquid portion of the mixture is evaporated to form a clear mass of considerable hardness which may be rolled out into thin sheets or drawn into threads.

Casein, being an animal albumen, is an important food. Many preparations possessing medicinal as well as food value are made with the aid of casein. It is also employed as a substitute for egg albumen for many industrial purposes, while it may be used in the manufacture of synthetic milk. A casein phosphate is employed in the manufacture of bread, while all sorts of special food preparations contain it.

The miscellaneous uses for casein are multitudinous and some of them are very surprising. As one goes over the field, it becomes rather remarkable that this substance which is contained in milk should have so varied applications. It certainly is enlightening to learn of what can be done with a comparatively simple substance, whose only apparent use, at least as far as Nature intended it, is to furnish part of the food value to milk. It may safely be said that in the case of casein man has certainly improved on Nature.

Casein is used in making shoe polish and shoe creams. It gives a product that produces a very high gloss on shoes polished with it. It has been employed in the manufacture of photographic plates in place of glass and possesses the important advantage over celluloid of being non-inflammable and over paper, mica and gelatine, which have been used for the same purpose, of not curling in the various baths in which it is placed during the developing process. Artists and scene painters use casein in preparing their canvases. It is used by the petroleum refiner to produce a solidified petroleum fuel. Soaps are made with it, and such soaps possess greater lathering power which is of special importance in the manufacture of shaving soaps and creams. It is also added to insecticidal preparations to make them stick better to the trees and plants.

Some Effects of Electric Currents on Fish

WHEN fish or other aquatic animals are exposed to continuous electric currents there appears at first a directing effect of the current, the animals placing themselves in line with the direction of the current in case of direct current; at right angles to this direction, if the current is an alternating one. This observation of a transverse position is new and has been observed with young specimens of *Salmo lacustris* (sea-trout), *Phoxinus laevis*, *Esox lucius* (pike), *Carassius lucius*, with embryos of *Rhodens amarus* (bitterling), with tadpoles and with a full-grown specimen of *Rana esculenta* (frog).

This effect of the current on the placing of the animal changes little by little into a deadening effect of electronarcosis. This narcotic effect appears earlier with older and larger animals than with younger and smaller ones. In its course it shows a considerable resemblance to the effects of narcotic chemicals.

After stoppage of the current the deadening is followed by a state of galvanohypnosis which has been observed already by Blasius and Schweitzer. This state is characterized by the fact that the animals lie at first without the least motion. On being touched, however, they move instantaneously in the most lively manner and thereafter behave quite normally. Such a hypnosis effected by alternating current was observed with very young specimens of sea-trout and other fish.—*Abstract of paper by F. Scheminzky in Pflüger's Archiv, Vol. 202, p. 200 (1924).*

Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

Outdoor Antenna But No Lead-In.—Many radio enthusiasts do not know that it is possible to make use of an outdoor antenna and still not bring any lead-in wire into the house. All that is necessary is to attach a coil of wire, like a loop antenna, to the regular outdoor antenna, carrying the circuit then to the ground. All this is outside, the coil being placed somewhere close to the wall. Inside the wall, near the place where the coil is placed outside, you set up an ordinary loop antenna connected to any kind of receiver. The energy surging back and forth through the coil outside will penetrate the wall and will be picked up by the loop inside. Of course this is not as good as a regular lead-in, but it will work fairly well, except in metal buildings.

The "Unitenna" is the new name given to an apparatus known as the "coupling tube unit" in the Navy. It permits of multiple reception on a single aerial. The large fighting craft of the United States are now equipped with this device. The S. S. "Leviathan" has been equipped with the "unitenna." Recent tests on the "Leviathan" by naval and Shipping Board experts proved that with the coupling tube unit messages could be received on 600 meters while the ship's six-kilowatt tube transmitter was radiating 25 amperes on 2100 meters. The transmitting tube was located only five feet from the receiving set in the tests, the antennae being parallel and only 30 feet apart. Other equally startling results have been obtained.

Crystals as Generators of Radio Waves.—A young Russian radio engineer, M. Lossev, working in the radio laboratories of the Soviet Government has invented a new way of using a crystal as a radio generator. The combination used is a zincite crystal and a steel point. Resistance and a battery are in the circuit and a tuned circuit is attached, so that the oscillations produced can be maintained and controlled. The device operates in much the same way as the arc oscillators that were popular before the advent of the vacuum tube. Radio amateurs in the city of Nishni-Novgorod, where Lossev's work has been done, are said to be using the new crystal hook-ups for local communication. It is very doubtful, however, whether these devices can compete at all with the vacuum tube as a generator of electric oscillations.

Variable Resistance to Facilitate Tuning.—There has just been introduced a variable resistance device designed to be mounted across the terminals of any transformer for the purpose of shunting more or less of its output so as to control the sound volume of the radio set without touching the dials or the rheostats. This device no longer makes it necessary for the operator to detune his set while searching for stations with a pair of telephone receivers. Instead, the output of the various transformers can be shunted, so that telephone receivers can be comfortably worn. Then, when loud-speaker results are desired, the shunt resistances are reduced if not eliminated altogether, restoring the full volume to the receiver. The variable resistance in this case is obtained by variable pressure on a pile of carbon disks.

Glass for Radio Sets.—One of the best insulating materials that we possess is glass, especially the varieties of glass that contain a considerable percentage of silica. One of the best of them is the familiar Pyrex glass much used for baking dishes and other kitchen glass ware. The loss of energy in Pyrex insulating materials is exceptionally low. Pyrex insulators for antennas and lead-in wires have been on the market for some time. Tube sockets of Pyrex are a more recent innovation. A condenser, especially designed for low losses, and insulated with short sections of Pyrex glass tubes, has been perfected and will be on the market very shortly. Pyrex glass is obtainable from dealers in chemical apparatus in the form of sheets, tubes, rods, plates and other shapes. It is likely to prove a valuable addition to the armament of the radio experimenter.

Short-Wave Transmission by the Navy.—Dr. A. H. Taylor of the Naval Research Laboratory has recently been experimenting with short-wave radio transmission. In one of his experiments he succeeded in spanning the continent with a 54-meter wave. A few days after this achievement, word was received from Rio de Janeiro, stating that his 54-meter wave had been intercepted in that distant Brazilian city. The distance spanned, in this instance, was 4780 miles over land and sea. These short-wave transmitting tests should be of significant interest to radio amateurs at this time, especially since the Department of Commerce has just opened several bands for their use below 200 meters. One of the bands includes the wave length used by the naval expert. Dr. Taylor has been transmitting on 54 meters on Monday, Wednesday and Friday nights at eight, nine, ten and eleven, and at half-past these hours on 100 meters, so that all amateurs might have an opportunity to test their receivers for the lower wave lengths.

Mercury-Arc Vacuum Tube Amplifies One Million Times.—Two French scientists, MM. L. Dunoyer and P. Toulon, described recently before the French Academy of Sciences a remarkable new amplifier that may have much importance in the future of radio telegraphy, if not in broadcasting. It is a form of mercury-arc rectifier and it is said to have an amplification of over one million times. The mercury arc is maintained by a local source of current, just as in the familiar devices used for converting alternating current into direct current. The electrodes between which this arc passes in the atmosphere of mercury vapor correspond to the filament and the plate of the ordinary vacuum tube. The third electrode, which serves as the control one analogous to the grid, is in the form of a metal cylinder which surrounds one end of the mercury arc, as a kind of sleeve. Alternations of potential supplied to this metal sleeve have a tremendous effect on the mercury arc inside it. That is how the amplification is obtained. As yet the new device has been used only in scientific work in the laboratories. It is reported, however, that it is soon to receive an exhaustive test in radio work at the hands of well-known Parisian radio experts.

The Magnavox Tube is the latest entry in the vacuum tube field. This tube, developed by the manufacturers of the well-known electrodynamic loud-speakers and power amplifiers, is said to follow an entirely new principle of construction which, it is claimed, represents a distinct advancement in tube design, with corresponding increase in efficiency. The new tube departs radically in every respect from the conventional vacuum tube. For one thing, it does not make use of a grid or any other kind of electrode interposed between the filament and the plate. This new construction permits the electrons to take an unobstructed path between the filament and the plate. By means of a new method of electron control, the tube gives not only higher amplification with greater sensitiveness, but also purer reproduction, so it is claimed. The elimination of the grid allows the spacing between electrodes to be much greater than in ordinary tubes and still maintain the same resistance, with the result that Magnavox tubes have less than half the internal capacity of other tubes of similar type. The tube is not critical in adjustment either as to plate or filament. The tube may be used as a detector, in which event it does not require a grid leak.

The Loud-Speaker of the Future.—In the very near future we shall witness a novel development in loud-speaker practice. It appears that, after all, the solution of the loud-speaker acoustic problem lies in the abandonment of the horn and the usual diaphragm, and in the adoption of the large parchment cone which serves as diaphragm and sound projector combined. One of the leading electric companies, famed for its contributions to the radio art, has been working for several months back on the final polishing, so to speak, of such a loud-speaker. While actual details are as yet missing, it appears that the finished job will be in the form of a parchment cone, to the apex of which will be anchored a rod leading to an armature which, in turn, will be actuated by the usual solenoids or electro-

magnets. The cone will be concealed in a neat container, which may be mounted vertically or horizontally. In the latter position it may be placed on the ceiling, in which case it will be quite inconspicuous. This general idea has been represented in a small loud-speaker which has been on the market for several years. However, the new loud-speakers will be of more ambitious dimensions and sound output, while the quality of reproduction, so we are assured, will be far ahead of anything yet achieved.

Is the Crystal Detector Coming Back?—There has been considerable discussion of late among radio experts regarding the status of the crystal detector. Some claim that it has outlived its usefulness and that it is little more than a relic of the radio past; others claim that it is coming back strong. The popularity of the reflex arrangement permits of the use of a crystal detector with excellent results, since there is ample radio energy to obtain good volume with such a detector. Then, too, the radio-frequency amplifier permits of the use of the crystal detector, if desired. Still again, with more powerful broadcasting stations, the crystal detector may be sufficiently sensitive to give us good phone reception, and eventually—who knows?—loud-speaker reception. Already, interesting experiments are under way in France, having for their objection the amplifying of signals with a crystal detector and a novel arrangement of batteries and resistance. For the present there are several good reasons why the crystal detector should be used, among them: 1. The so-called soft tube used as a detector has tube noises. A crystal rectifier has none. 2. A crystal is cheap; a tube is not. 3. There is no upkeep cost to a crystal detector. It consumes no current. 4. No tube gives the clarity and purity of tone of a crystal. Present-day crystals are of good quality, and are not to be judged, or rather misjudged, by the poor material sold in the early days of radio broadcasting, when anything "went."

Standard Frequency Stations.—As a result of measurement by the Bureau of Standards upon the transmitted waves of a limited number of radio transmitting stations, data are given in each month's *Radio Service Bulletin* on such of these stations as have been found to maintain a sufficiently constant frequency to be useful as frequency standards. There may be many other stations maintaining their frequency just as constant as these, but these are the only ones which reached the degree of constancy sought from among the stations whose frequencies have been carefully measured in the Bureau's laboratory. There is, of course, no guarantee that the stations named will maintain the constancy shown. As a means of maintaining constant frequency, the high-power low-frequency (long wave length) alternator stations listed in the *Bulletin* have speed regulators. Most of the broad casting stations which are listed use frequency indicators (one-point wave meters) and maintain a maximum deflection of the instrument on the frequency indicator throughout the transmission. These broadcasting stations, with rare exceptions, vary not more than two kilocycles from the assigned frequency. The transmitted frequencies from these stations can be utilized for standardizing wave meters and other instruments by the procedure given in the Bureau of Standards Letter Circular No. 92, "Radio Signals of Standard Frequencies and Their Utilization." A copy of that letter circular can be obtained by a person having actual use for it, upon application to the Bureau of Standards, Washington, D. C.

A Variable Loop which is claimed to reduce static interference is the inventicn of Pierre R. Werner, a consulting engineer of Brooklyn, N. Y. The mechanical features of this loop include an ingenious folding frame, flexible wires and a small insulated handle the manipulation of which permits of raising or lowering the frame, so as to raise or flatten the loop as desired. According to the inventor of this variable loop, this loop serves to reduce static interference when operating a sensitive radio-frequency receiver. Suppose, for example, that the signal audibility is four times that of the static or noise level. This condition would result in the reproduction of parasitic disturbance in too large a volume for the pleasure of the listener. It would form a most disagreeable background. If an attempt is made to reduce the sensitive adjustment of the receiver so as to drop out the parasitic noises in the background, then the signal strength drops off rapidly and no

useful purpose is served. It is held that the most satisfactory method of reducing the parasitic disturbances or static level is to cut down the total energy collected by the loop antenna to such an extent that for a given sensitiveness of the receiver, the static energy received is of too small a magnitude to be effective. The desired signals will still be reproduced with a good degree of intensity, and will stand out by itself in the quiet background now resulting. Radio men who have had an opportunity of trying out the Werner loop are quite enthusiastic in endorsing it. They claim that the variable feature of this loop permits of eliminating much of the static disturbances while still retaining sufficient signal strength.

Fans Now Pay Attention to Losses in Sets.—One of the foremost signs of the times in radio land is the increasing attention being paid to the prevention of losses of signal energy in and between the instruments in a receiver. "Low loss tuners" are the order of the day. The impelling reason for this seems to be the desire to use the loop antenna, with its comparatively small pick-up of signal energy and its equally small pick-up of static. Small antennas and high amplification have been found to give clearer signals than any other way of disposing of the natural interference produced by lightning and other atmospheric disturbances. With such extremely sensitive sets, even a very little loss of energy in the coils, transformers or condensers becomes a fatal defect. There are two important sources of loss in a radio receiver. One is high resistance of the wires or other parts. The other—and usually more important one—is the presence of something that absorbs energy from the electromagnetic field that surrounds the instruments. Suppose, for example, that some metal object is so placed that it cuts the lines of force from a tuning coil. Some of the energy in that coil will be absorbed in the metal and dissipated as eddy currents. Low-loss design requires, therefore, not only the proper design of the instruments themselves, but the proper placing of them with reference to each other. Another important source of losses is the insulation on the wire. Air is the best insulator ordinarily obtainable. Accordingly for radio-frequency currents, bare wire is the best where it can be used. Enameled wire is next best, provided the enamel is of the best quality. Silk-covered wire is next best. Cotton-covered wire usually has the greatest losses of all.

The Third National Radio Conference, called for September 30, has been held in Washington. Two such conferences have already been held, one in February, 1922, and one in March, 1923, both of which were generally attended by the persons and organizations interested. The result has been a lessening friction and misunderstanding through the voluntary cooperation of the radio industry, the public, and the Department of Commerce, especially in the reduction of interference and the improvement of service. The growth of radio, and particularly the multiplication of broadcasting stations, with the consequent congestion of the air, has made necessary a consideration of many subjects and perhaps a revision of some present methods. Some of the matters which will have been discussed, no doubt, before this note comes to the attention of the reader, are: Revision of the present frequency or wave length allocations, to reduce interference. Use of high-frequency or short waves. Classification of broadcasting stations; possible discontinuance of Class C stations. Interconnection of broadcasting stations. Limitation of power; division of time; zoning of broadcasting stations. Means for distinguishing the identity of amateur calls from foreign countries. Interference by electrical devices other than radio transmitters. Relations between Government and commercial services, and such other topics as may be proposed by the conference. To facilitate the work of the conference the various groups in the radio field have been asked to name representatives who will constitute the formal advisory committee of the conference. As planned at the present writing, the groups to be represented are: listeners, marine service, broadcasting (one from each inspection district), engineering, transoceanic communication, wire inter-connections, manufacturers, amateurs, point-to-point communication, and Government departments. The conference is an open affair, and will hold public hearings. All persons or organizations having any suggestions to make or views to express upon any features of radio activity are urged to attend and will be heard.

The Basic Circuits of present-day receiving sets are the regenerative, the radio-frequency, the reflex, and the super-heterodyne. The regenerative circuit appears to have declined in popularity to a very great extent. It has been sadly misrepresented of late—made to appear as a crude toy which has caused no end of mischief to the radio broadcasting cause in the hands of careless and uninformed owners. This is due to the radiation feature of the regenerative set, which means its ability to oscillate and radiate radio waves which are picked up by sensitive receivers over quite a range, these radiated waves causing serious interference with the reception of radio programs by others. In fact, most of the squeals and groans that abound in the air of any congested locality, are due to regenerative receivers in the hands of untutored individuals. However, the regenerative principle is so simple yet so efficient that it is but a matter of time before it again comes back into favor, no doubt with marked innovations which will eliminate the radiation feature. As for the radio-frequency circuit, represented by numerous variations, it appears to be not only the most popular classification of the present moment, but to be decidedly in the ascendency. For the time being it is best represented by the highly popular neutrodyne receiver. However, there are bound to be many new ideas in the way of inter-tube coupling. The reflex circuit has for its object the dual function of the vacuum tubes. That is to say, a vacuum tube is made to do double duty, such as radio-frequency amplification followed by audio-frequency amplification. The signal is reflexed, in other words. While this idea is highly ingenious and appealing from a theoretical standpoint, it has not fared so well in everyday practice. Much remains to be done by way of perfecting the reflex circuit. However, although the reflex circuit does save on the number of tubes required, so that it enables very compact receivers to be operated on small loops and dry batteries, its economy in tubes and battery current is no longer of prime importance in these days of economical tubes. The super-heterodyne circuit has many points in its favor. Much remains to be done to make this receiver simpler and more economical to operate. Most receivers of this type have too many tubes for the average radio enthusiast.

The Static or Noise Level is more and more a subject of discussion in considering receiving set performance. By static or noise level is meant the extraneous or parasitic disturbances heard with a receiving set and causing more or less interference with the reception of desired broadcasting programs. During the summer the static or noise level is very high, while in the winter time it drops down to such a low level as to be practically non-existent, or simply a "background" to the radio signals. Static is by no means the only contributing factor to the noise level. Local conditions, such as a defective "B" battery or leaky storage battery, poorly soldered joints, soldering flux in odd corners, a poorly insulated panel—these factors and many others cause disturbances in the receiving set, and contribute their quota of annoyance to the static or noise level. The static or noise level determines just how far we can receive. Thus, when this level is high, it reaches up into our signal level, so that the parasitic sounds break up our intercepted programs. The signal level depends on the power of the transmitter, as well as its proximity to the receiver. Hence if we be satisfied with nearby and powerful transmitters during unfavorable atmospheric conditions, we are less bothered by the static or noise level than if we intercept a distant station, with its weak signal level which will be entirely overrun by the static or noise level. As things now stand, we have developed receiving sets which are about as sensitive as it is practical to make them. A good receiving set of today will intercept the Pacific coast broadcasters on a crisp winter's night. What more could be desired? Yet that same receiver, by virtue of its ultra-sensitive performance, will intercept atmospheric disturbances several thousand miles away. It will pick up the sparking of a vacuum sweeper motor a block away. Its static or noise level is very high—exceptionally high, because it has been made so sensitive. Hence it will be noted that the limiting factor today is the static or noise level. We have reached the point where we can no longer increase the sensitiveness of our receivers, for already the static or noise level has caught up with the distant signals.

Grafting Experiments on Vegetables

GRAFTING, a procedure quite common in tree culture, has been applied to vegetables and flowers by a French botanist, Professor Lucien Daniel, of the University of Rennes, who has by this method increased the size and yield of vegetables, created new species and prolonged the life of plants, and intensified the perfume of flowers. Professor Daniel has performed such grafting operations on cabbage, lettuce, beans, potatoes, tomatoes and various flowers.

One of the first attempts made by Professor Daniel was to graft the black Belgian bean on a large white Soissons bean. From this combination plant there were obtained seeds of an entirely new variety of beans which has remained fixed. He also took a bitter variety of cabbage unfit for food, but resistant to frosts, and grafted on it a variety that has a good flavor but succumbs easily to cold. The seeds of the hybrid yielded a new variety that tastes good and resists cold.

Some of Professor Daniel's most sensational grafts were made on the family *Solanaceæ* to which belong such useful plants as potatoes, tomatoes, tobacco and egg plant. He grafted sections of egg-plant on tomato vines. First the grafts produced the regular ovoid egg-plant fruit and later on the same branch yielded other fruit resembling that of tomatoes. Finally a true hybrid, round in shape, was obtained. Professor Daniel also grafted tomato branches and belladonna on potato vines, and potato stems on egg plants and tomato vines. Potatoes, of course, are tubers which develop underground. It was a question as to what would happen when a potato stem was grafted on another plant. Would tubers continue to be produced? It was found that they were, but not underground. Large beautiful tubers hung from the branches like fruit. These aerial tubers when planted yielded a new kind of underground potatoes which were more resistant and developed more quickly than those of which they were the offspring.

A still more fantastic discovery was the finding, among these second-generation hybrids, of three plants which bore both aerial and subterranean tubers at the same time. These tubers being harvested and planted yielded a stable new variety rather late in developing, but delicious in flavor, extra large in size and very hardy.

One of the most recent experiments is the double grafting of belladonna and tomato. Upon a tomato stem, a sprig of belladonna was grafted and then upon the latter again a tomato stem. It was found that the belladonna plant had by this operation lost its property of producing atropin poison which is normally found in all parts of the belladonna plant.—*Abstract from Science for August 1, 1924.*

Illuminating Gas and Growing Plants

A CONCENTRATION of illuminating gas may occasionally be present in the air around a plant sufficient to exceed the very low concentration necessary to produce toxic effects. In greenhouse practice, where the air space is limited and ventilation is restricted, leaky gas pipes may provide dangerous quantities of unsaturated hydrocarbons in the air. In urban conditions, with wide surface areas covered by pavement and asphalt, coal gas leaking into the soil may accumulate until toxic effects are produced upon the roots of trees. American experience seems to suggest that such action may require consideration where trees are grown for shade in public thoroughfares.

But many other factors are always at work, in urban conditions, to oppose the healthy growth of the plant, and the practical problem seems to be to ascertain, in any case where injury is experienced, whether this can be indubitably traced to the poisonous action of gas. The concentrations of gas shown to be effective are far below the concentrations which can be detected by smell. Professor Doubt, in some American experiments, states that frequent trials failed to detect the odor when the gas was present in concentrations lower than one part in 400 of air. On the other hand, with this same gas supply, concentrations of one per 1000 were very harmful to many plants.

The escape of gas may fail to be detected, therefore, save by the effect produced upon the plant, and since, when the original damage has been done, plants are very susceptible to fungus disease and when examined show clear signs of the effects produced by such secondary causes, damages originally due to the continuous action of traces of coal gas may be ascribed on examination entirely to these secondary factors. Remedial measures directed to remove these secondary factors may therefore leave the root of the trouble untouched. Doubt's suggestion to florists is that where harmful contamination by coal gas is suspected, vigorous plants of tomato or the castor-oil bean or other suitable plant should be placed in various places in the house and left there for 24 to 48 hours. Within this period at ordinary temperature the plant will show poisoning in the presence of traces of the gas. With concentrations well below detection by odor, the plants named will drop their lower leaves abnormally early.

To these suggestions of Doubt the following additions can be made. If the effects of gas poisoning are examined at an early stage, structural effects as the following may be found: In the roots, swellings associated with gaps in the endodermal cylinder; in stems, lesions in the cork; loose proliferated tissue at the lenticel, and, generally throughout the plant, fatty deposits, accumulated in the neighborhood of the surface.

In cases where physiological experiment is not excluded by practical requirements, the atmosphere may well be tested by growing etiolated pea shoots (shoots grown in the dark) or young pea or bean roots and by keeping them under examination. Forty-eight hours will normally provide unmistakable evidence of the presence of toxic concentration of gas. The reactions of the etiolated shoots in particular are exceedingly characteristic and exceedingly unlikely, in greenhouse practice, to arise from any other cause.—*Abstract from article by J. H. Priestley, Science Progress, April, 1924.*

The Fixation of Nitrogen by Yeast

A YEAST has been discovered by Dr. E. I. Fulmer, of Iowa State College, that is regarded in informed circles as having immense future possibilities in enlarging the available supply of nitrogenous food. It is a variety of yeast capable of assimilating nitrogen directly from the air when grown in a solution of sugar and of minerals, free from any other source of nitrogenous nutriment.

This new yeast, known as Saccharomyces Cerevisiæ, Race F, was developed from a cake of commercial yeast. The secret of this success lies not only in the race of yeast used, but also in the use of the proper balance of salts and sugar in the medium in which the yeast is grown.

Hitherto the only organisms of any economic importance capable of assimilating nitrogen from the air have been the nitrifying bacteria which grow on the roots of clover and other leguminous plants. The nitrogen absorbed by these organisms is not directly available as food for man or beast, but occurs chiefly in the form of nitrates which nourish the following crop.

The new yeast is what may be called a domesticable organism, suitable for direct consumption by man and animals. It does not require for its growth a preexisting supply of nitrogen in the form of nitrates or ammonia.

The potential importance of this discovery lies in the fact that it indicates a possible way of utilizing enormous quantities of saccharine materials which now go to waste, especially in the outlying regions of the world. For example, the cane-sugar industry, which is mainly confined to tropical regions, produces vast amounts of molasses for which no market can be found, notwithstanding that large amounts are employed in the manufacture of alcohol and stock feed. Molasses consists mainly in carbohydrate in the form of sugar. Carbohydrates are, in general, the most abundant of the common constituents of foods, but they can not take the place of proteins—that is, of the foods containing nitrogen. By using cheap and abundant carbohydrates to support the growth of yeast while it is fixing the nitrogen of the air in the form of protein, the economical production of nitrogenous foods may be greatly expanded.—*Abstract from Science for August 1, 1924.*

Tuberculosis

IN regard to the tubercle bacillus, it is so widespread, so ubiquitous in civilized communities, passing from one infected host to infect another, that it would seem impossible under existing conditions to prevent its spread. At present it is taught, and on what seems good evidence, that the majority

of the population of our crowded cities has at one time or another been attacked by this disease. But in every hundred men who die in England, only about ten die of tuberculosis, which shows that a large percentage of the population successfully resists the tubercle bacillus. When this occurs it means that the person attacked possessed powers of resistance which enabled him either to destroy its invading bacilli or to otherwise deal with them so as to render them harmless.

A point of importance in this connection is that it has recently been demonstrated that the disease is usually acquired in childhood. The fact is of capital significance, for, if the disease is recognized sufficiently early and the child is placed under good hygienic conditions, there is a very good chance of effective resistance and immunity being set up against a second attack. The present evidence goes to show that the presence of a latent tuberculosis infection prevents a second invasion. If further outbreaks take place, they would seem to be due to a flaring up of the old latent infection rather than to a fresh infection.

Metchnikoff studied the question in a remote part of Siberia where the tubercle bacillus was unknown. He states that very many of the young men and women who migrated from this clean country into the big cities died of acute and rapid tuberculosis, on account of not having been exposed to infection in their childhood.

The experience of Colonial troops in the late war is instructive. Thus, in France, the Senegalese, who are almost without tuberculosis in their native condition and were found to be free from tuberculosis on reaching France, developed in large numbers an acute and fatal form of tuberculosis in spite of the hygienic measures enforced by the army authorities. This raises a curious point. If it were possible for any country to clear itself of the tubercle bacillus, it would appear to be incurring a great risk for an inhabitant to migrate into any neighboring country.—*Abstract from presidential address by Sir David Bruce, Toronto meeting, British Association for the Advancement of Science, August, 1924. Science, August 8, 1924.*

Health and Its Correlations

THAT health is not necessary for good nature in children, and that neither health nor the lack of it is always or even frequently associated with vivacity, popularity or conscientiousness, is the finding of Dr. Karl Pearson, as the result of a study of about 2000 boys and 2000 girls in English schools. Dr. Pearson also found only a slight correlation between health and general intelligence.

Dr. Pearson's results further show that athletic prowess goes with good health, as does also self-assertiveness; but the old idea that delicate children take to intellectual work and are particularly shy and conscientious is not confirmed by him, nor is the similar idea that lively boys are likely to neglect studies for physical sports.

Dr. Pearson's results seem to shatter widely held beliefs. They indicate that it is not possible for teachers to modify general intelligence or psychic characters, which seem to be unchanged throughout the whole of school life; that general health changes little during the school period; and that health is not a governing factor of temperament. Health was found to be associated to only a slight extent with qualities of character, and with temper practically not at all.

Professor Pearson also concludes, as the result of a similar statistical study of 1600 babies from a large manufacturing town, that for their good health babies depend more on their heredity than upon the station of life in which they are born, or the care that they receive. The poor health of babies that are not breast-fed is found to be chiefly due to the inheritance of the weakened constitution of a mother not able to nourish her child. Clothing is important, but it is not highly correlated with health and it becomes less important as the child grows older.

The health of the father and mother is most important, and it is stated to have more to do with the health of the child than the wages of the father or the employment of the mother. It is probable that these conclusions, if confirmed by later independent investigation, will make it necessary to restudy the ideas now held by nearly all authorities on education, school management and the health and training of children.—*Abstract from Science for May 30, 1924.*

Our Post-War Navy

(Continued from page 315)

craft, some transports, auxiliaries, and old obsolete cruisers, can be placed out of commission without hurting the real Navy. The operating expenses of such vessels can be saved and their crews distributed to the essential vessels. Such of these vessels as still retain real useful qualities can be kept available without being in active service. Although a considerable number of unnecessary naval stations have been closed, various naval establishments not essential to the real Navy are kept up or kept open in greater numbers than actually needed. This is due largely to the influence of local interests. This should be stopped since it merely wastes the taxpayers' money and does not help the Navy, the naval personnel, or the public. We must make sure that every one of the dollars spent produces somewhere near a dollar's worth for the Navy. This cannot be accomplished if a considerable amount of the money is spent on unnecessary facilities or in maintaining in service facilities materially beyond those required for service to the fleet.

If allowed to use a certain amount of discretion in the distribution of the total funds allotted, or if unexpended balances and proceeds of sales could be made available for experimental work and new construction, the Navy Department might be able to reduce materially some of the wastes now going on. It is certain that the liberty to exercise such discretion would put an incentive before the Navy to take action in this direction.

The Human Heart as an Engine

NOTWITHSTANDING the high development of human ingenuity, technical skill and knowledge of mechanical principles as well as of materials, man has never been able to construct an engine capable of functioning without interruption and without requiring cleaning, repairing or the renewal of worn-out parts during a period of 70, 80 or more years. Even the best man-built engine ever invented and constructed is infinitely inferior in efficiency and durability to the human heart, which may justly be considered one of the most efficient motors known.

The human heart is a motor, approximately as large as the fist of an adult, weighs about 300 grams and represents on the average 1/375 horsepower. With each stroke labor is produced sufficient to lift a one-pound weight to the height of one meter. The number of heartbeats, which may be called the strokes of the lift-and-force pump which the heart really is, averages under normal conditions about 100,000 in 24 hours, or nearly 40 millions a year. In seventy years the heart, working without interruption, would beat 2,800,000,000, or nearly three billion times.

The work of the heart is twofold: with every stroke it draws from the veins 1/10 liter of blood into the right auricle, forces it into the right ventricle and thence through the pulmonary artery to the lungs where the blood is purified by oxygenation; from the lungs the rejuvenated blood is sucked by the pulmonary vein to the left auricle, then to the left ventricle which forces it through the great systemic artery or aorta to all parts of the body, completing the circle of blood motion.

In one minute the human heart sucks and again forces back into circulation 7 liters of blood, which makes more than 300 liters an hour and more than 5000 liters a day. In a single year the heart draws in and forces out almost 4,000,000 liters or 40,000 Hektoliters. The quantity of blood pumped by the heart in seventy years would fill a tank with a capacity of more than one-quarter million cubic meters.

Let us assume that a passenger elevator could be so constructed that the heart of the attendant supplied the lifting force, the elevator cage carrying the weight of the attendant would rise about 35 centimeters a minute or more than 20 meters an hour. A cog-wheel car driven by heart-power would reach the top of Pike's Peak in a trifle more than one week.

If it were possible to utilize the motive force of the human heart during a whole lifetime by placing the heart of a newly born child into a spherical container set in rolling motion by the heart, the sphere could roll around the earth in one year, traveling at the rate of $1\frac{1}{4}$ meters a second. Day by day, regardless of time, weather or season, it would continue rolling without stopping for a single moment and without materially diminishing its tempo for sixty years. Then

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[*All the above books are obtainable from the Scientific American Book Department, 233 Broadway, N. Y. C.*]

The Human Heart as an Engine

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it would probably diminish its speed. On its next trip around the earth it would reach the starting point perhaps a week late and on the following trip a few days later. Yet, though slower, it would continue on its course for another five, ten or fifteen years, becoming steadily more sluggish and hesitating in its action, until at last its energy has become too feeble to overcome even minor obstacles in its path. The ball stops rolling and after a short time the action of the heart ceases forever, having circled the earth approximately seventy-five times.

It is safe to say that even the most perfectly designed and constructed motor built by man from the best materials could never approach the record of the heart.

Putting Heat in the Bank

(*Continued from page 318*)

system of the kind called solid solution.

Steels but moderately below the eutectoid ratio have only the single upper transformation, which gives changes that are a combination of those detailed for the two upper transfer points in the very low-carbon steel. The subsequent transformation at the lower critical point is identical with that already discussed.

In eutectoid steel all the transformations are telescoped into a single critical point. This marks the change of the austenite into pearlite; and the change in properties is a combination of those found in the three transformations for low-carbon steels. The separation of these changes is a function of low-carbon content; as the carbon rises toward the eutectoid ratio the transformations come together.

The size of the octahedral or cubical grains or crystals varies with the rate of cooling in all cases. If a piece of properly made steel is heated, no change in grain size occurs until the point is reached where the pearlite is transformed into a solid solution of austenite. To obtain the complete refinement which exists here it is necessary to heat a little above the upper critical range; but not too much, for as heating continues grain size enlarges. Upon cooling from the liquid state steel, say, of eutectoid composition solidifies into crystals, which will be the larger, the slower the cooling. These grains (of austenite) continue to grow until the lower transformation point is reached, where each is changed into a grain of pearlite. This results in a structure of large grains, making the metal weak and brittle. Increase of time at heat has a similar effect.

With a straight-carbon steel heated through the critical range, maximum refinement occurs just above this point, and then grain growth begins immediately. This growth is retarded, however, by the presence of alloys. It is possible to harden alloy steels at any temperature from just above the critical to as much as 150 degrees above. This range of hardening temperature is of great value. These facts are of vital importance to the steel treated.

In general it may be said that carbon decreases the transformation range. In the presence of another element of a similar tendency the effect is cumulative, and we get "air-hardening" steels that harden by cooling in air. Nickel has a marked effect upon the critical range: first lowering it to a minimum that comes with 25 per cent nickel, where we have a non-magnetic air-hardening steel; then raising it again to a maximum with 70 per cent nickel. Nickel also lowers the eutectoid ratio; and then the lowering of the critical temperature means that the maximum grain refinement comes with a lower temperature than in a carbon steel free of nickel.

Manganese lowers the critical range by about 5.4 degrees for each 0.1 per cent of manganese, until with about 13 per cent the lower recalescence point is below atmospheric temperature, giving a non-magnetic steel in which the graphitizing tendency of cementite is opposed. Chromium has little effect upon the critical ranges. It forms an iron-chromium cementite, not so readily dissolved as the ordinary cementite, which in quenching tends to prevent the transformation of the austenite and so adds hardness. This property is operative only in the presence of sufficient carbon. Chromium also retards grain growth when heated above the critical range, and hence widens the hardening range.

Vanadium and molybdenum have little effect upon the critical ranges of steel. Up to five per cent tungsten raises these; beyond this percentage it lowers the critical points under cooling from higher temperatures. Silicon, sulfur and phosphorus in small amounts have no marked effect upon the location of the transformation ranges.

Hot working done as the metal cools from above the upper critical point to the lower one tends to prevent the massing that causes coarseness, and which occurs freely when working of the metal is discontinued at too high a temperature. But it must be realized that if the outside of the metal, which alone can be subjected to test, be at the critical point, the inside will be hotter and will therefore become coarser on cooling. Cold working—the term includes all working below the lower critical point—does not aid refinement, but rather tends to cause distortion and brittleness.

For annealing the steel is heated through the critical ranges, held at heat to permit proper penetration so that the transformation may be completed throughout the mass, then allowed to cool slowly. The rate of cooling through the lower range will, as we have seen, affect the physical properties markedly. Annealing may be carried out with any of three objects: to change the structure, to increase machinability, or to relieve strains. The particular object in view will determine the exact procedure; the second of the three aims is the most difficult in practice.

Hardening calls for the formation of the hardest possible constituents with the smallest grain size. Fortunately an optimum point can be found above the critical ranges. To heat to a lower point would sacrifice hardness of constituents, and to go higher would enlarge the grains. Having attained the desired quenching temperature, speed of cooling is of the utmost importance to prevent the normal transformation of recalescence from taking place. Any desired degree of less-than-maximum hardness may be obtained by slowing up the cooling. In the hardening process, however, strains are set up that cause the metal, while retaining its hardness, to be too brittle for bearings, tools, etc.; so when destined for such use, the final shapes are reheated to some point below the lower critical temperature in order to relieve these strains. This is tempering.

The oldest and perhaps the easiest method of control is to take samples of the steel to be treated, heat them to various temperatures, quench them, fracture them, and examine them for the piece possessing the proper fineness of grain and hardness. The chief drawback here is that the frequent differences in mass between the test sample and the piece heated for production purposes means that the latter will not necessarily enjoy the same temperature throughout when its exterior registers the same number of degrees. Slower or faster heating, or longer exposure to the ultimate temperature, are the remedy here.

We have seen that steel is magnetic in the alpha form, feebly so in the beta, and not at all so in the gamma. This principle has been utilized for many years in the location of the critical ranges. It more nearly eliminates the equation of personal judgment than the cut-and-try method outlined. Again, we have noted that in addition to the checking and even the reversal of temperature increase or decrease at the points of calescence, the ordinary phenomena of expansion and contraction are checked or reversed. A method of taking advantage of this depends ultimately upon the motion of a pointer controlled by copper jaws that grasp the piece and serve at the same time as electrodes for the introduction of a heating current.

But the most exact method of all is control through the recording pyrometer, based upon previous determination of the critical points. The application of the pyrometer in this matter is ingenious. The piece undergoing treatment is enclosed in a shell of another metal—say, nickel—which has no transformation points in the range through which heating is to be carried out. One pyrometer registers the temperature of the nickel, another, having one end in the steel and one in the nickel, registers the temperature difference between the two. As soon as this one departs materially from a zero reading, it is plain that a transformation point has been reached, at which the steel is departing from uniform heating. But with this as with all other methods of control, it is hard to get good results or uniform results in the absence of knowledge as to the exact changes taking place at the several transformation points, and the meaning of each of these changes in terms of the ultimate properties of the finished piece.

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It is a non-conductor of electricity.

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